Vol. 12 JUNE, 1929 No. 6

Journal

of the

American Ceramic Society

Abstracts
Vol. 8, No. 6

Bulletin
Vol. 8, No. 6

A Monthly *Journal* Devoted to the Arts and Sciences
Related to the Silicate Industries

Publication Office: 20th & Northampton Sts., Easton, Pa.

Editorial and Advertising Offices: 2525 N. High St., Columbus, Ohio.

Executive Office: 2525 N. High St., Columbus, Ohio.

Committee on Publications: F. K. Pence, *Chairman;* A. Silverman, L. Navias, J. Spotts McDowell, A. E. R. Westman, Ross C. Purdy.

Entered as second class matter at the post office at Easton, Pa., under the Act of March 3, 1879.

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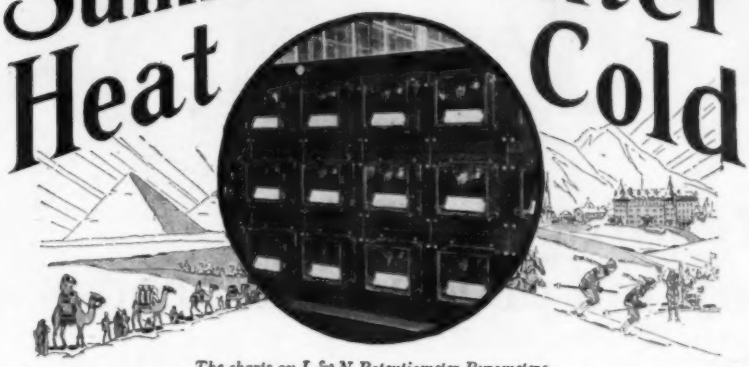

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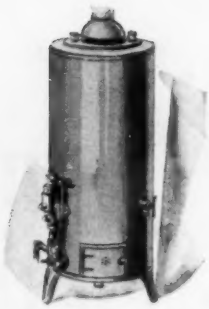

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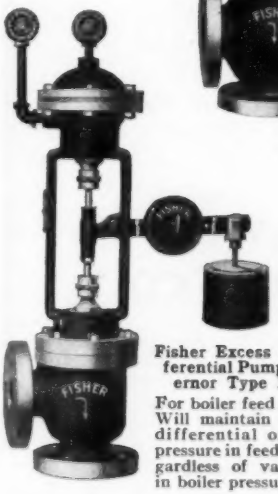

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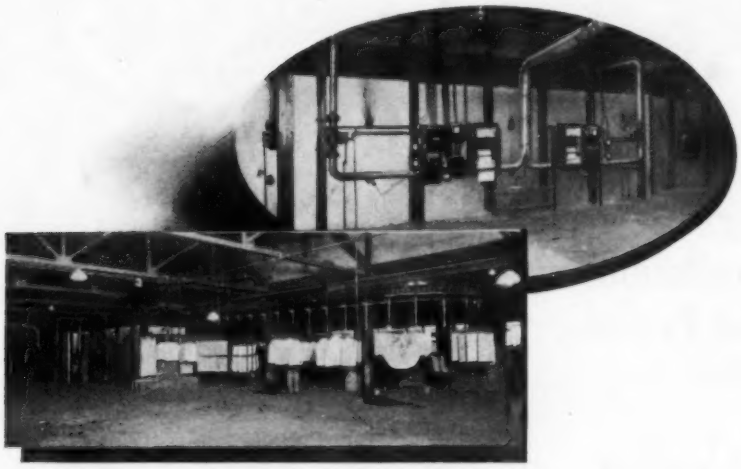

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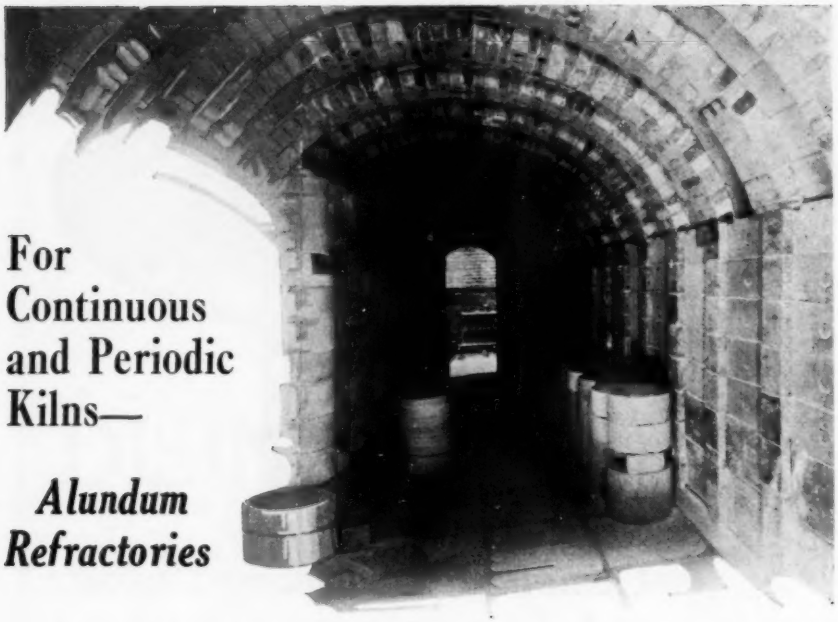

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IMPORTANCE OF THE GLASS PHASE IN PORCELAIN[1]

By Hobart M. Kraner

ABSTRACT

This paper discusses the probable developments taking place in porcelain during the firing and overfiring processes. Evidence is given for the belief that mullite solution in the glass may be the cause of change of characteristics of the porcelain. Observations in the clay-flint-feldspar system and in the magnesia-alumina-silica ternary are discussed in connection with the above subject.

Introduction

The petrographic microscope makes it possible to determine the effects of various mineral constituents which are either added to or developed in ceramic bodies and in a broad way the causes of variation of characteristics of ceramic products. It also enables us to determine to a certain extent the effectiveness of solvent action of fluxes upon the mineral constituents of these bodies. In each of these cases the fundamental use is, of course, to examine the crystal phase.

It is possible to determine indirectly from the crystal phase what is happening within the glass phase. Unfortunately, however, it is impossible to determine in this just how homogeneous the glass phase is or to what extent it has become associated as submicroscopic or uncrystallized minerals which give definite characteristics to a ceramic mass.

Microscopic and theoretical studies of this kind, in which the glass phase is kept uppermost in mind, are interesting and should afford considerable food for thought, especially for those who generally believe that the crystal phase is all-important. It is with all of this in mind that the following studies and observations are discussed.

Relative Importance of Solvent and Solute

In vitreous clay-flint-feldspar porcelain, feldspar is the flux, but peculiarly, only the extremely fine-grained material seems to disappear in the solution upon firing. This goes into solution with the clay and some of the quartz. The larger grains of feldspar remain as such. To be sure, the large feldspar grains become soft and isotropic at porcelain firing temperatures but they do not deform and diffuse through the body. This is evidenced by the fact that mullite needles penetrate the melted grain which has retained its original shape, even though melted. (See Fig. 1.) In large grains, where the section is taken through the center, the depth of penetration can easily be observed to be quite shallow.

Since quartz does not soften in the porcelain fire it cannot be united in the mass by this needlelike development. If it is held firmly in the

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (White Wares Division.) Received March 22, 1929.

mass it is cemented in place by a glass which wets it. Such wetting, of course, is dependent upon some solubility of the quartz in the surrounding glass. This is shown in studies of high fired porcelain where relatively

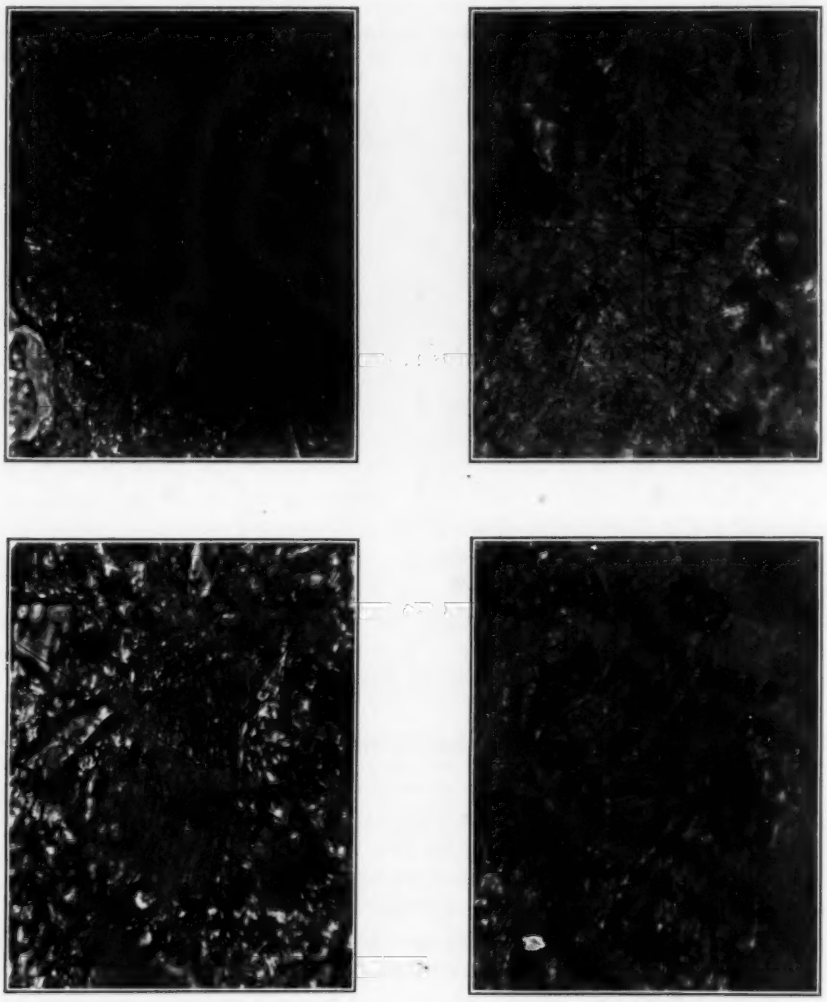


FIG. 1.

inert materials such as mullite are used in large proportion and in fairly large grain sizes. In these, the fluxing materials play a very important part and their function is glass-forming, crystal wetting, and consequently bonding.

It would seem that the glass phase which is of such a composition and character as to wet the crystal is of greatest importance. It would also seem that the weak link in such a combination of constituents may be the glass, due to the fact that neither crystal phase, quartz, nor mullite, is continuous.

It is apparent that synthetic mullite is not entirely responsible for the high strength of the so-called high strength porcelain compositions. It is also well known that mullite introduced in a clay-flint-feldspar composition contributes little or nothing toward higher strength unless the feldspar is partially or wholly eliminated. Such action, of course, increases the refractoriness but at the same time changes the character of the glass bond in such a vitrified body and we may then safely assume that the glass portion is of greater importance than the mullite developed or introduced.

Blebs developed in overfiring have not been explained. They seem to develop first in the center of the original feldspar grain as a pit. Stronger firing enlarges the pit, seemingly dissolving the mullite crystals which had penetrated into the fused crystal. During this process silica is also dissolved, producing a glass in which the mullite and quartz are less soluble. Schwartz and Merk[2] have pointed out that feldspar dissolves not only quartz but mullite as well. According to their work on normal firing of a typical German porcelain, feldspar dissolves mullite to the extent of 9%. It appears that this is quite probable for in those pits or craters, developed in an overfired porcelain the mullite needles disappear in the glass. It may be argued that probably these needles are broken off in the grinding of the section, but it must be remembered that no needles are apparent in the solid glass immediately surrounding the pit.

Schwartz and Merk point out that several firings of a porcelain increases its strength. They noted the solubility of mullite in feldspar glass and this solution proceeded until the action was retarded by acidification of the glass by the quartz dissolving in it. The mullite crystals grew large to a certain degree and this degree appeared to be limited by the solubility of the mullite in the glass as well as the increased viscosity of the resulting glass by the solution of quartz.

German porcelain is, of course, a high quartz, low feldspar type, distinctly acid and in which a greater length of time under fire is probably required to bring about equilibrium at a given temperature. To be sure most of this would take place in first fire and further changes would follow an asymptotic curve. We have found similar increase of strength as was noted by Schwartz and Merk to take place in our more feldspathic porcelain in two fires. Schwartz and Merk found a weakening after four fires, whereas we find a slight weakening with the third firing. The

[2] "Constitution of Porcelain," *Z. anorg. Chem.*, **156**, 1 (1926).

crystal growth of mullite was not sufficiently coarse, however, to be logically blamed for this weakening due to the fact that these crystals were still of a needle or hairlike variety and it would appear that the

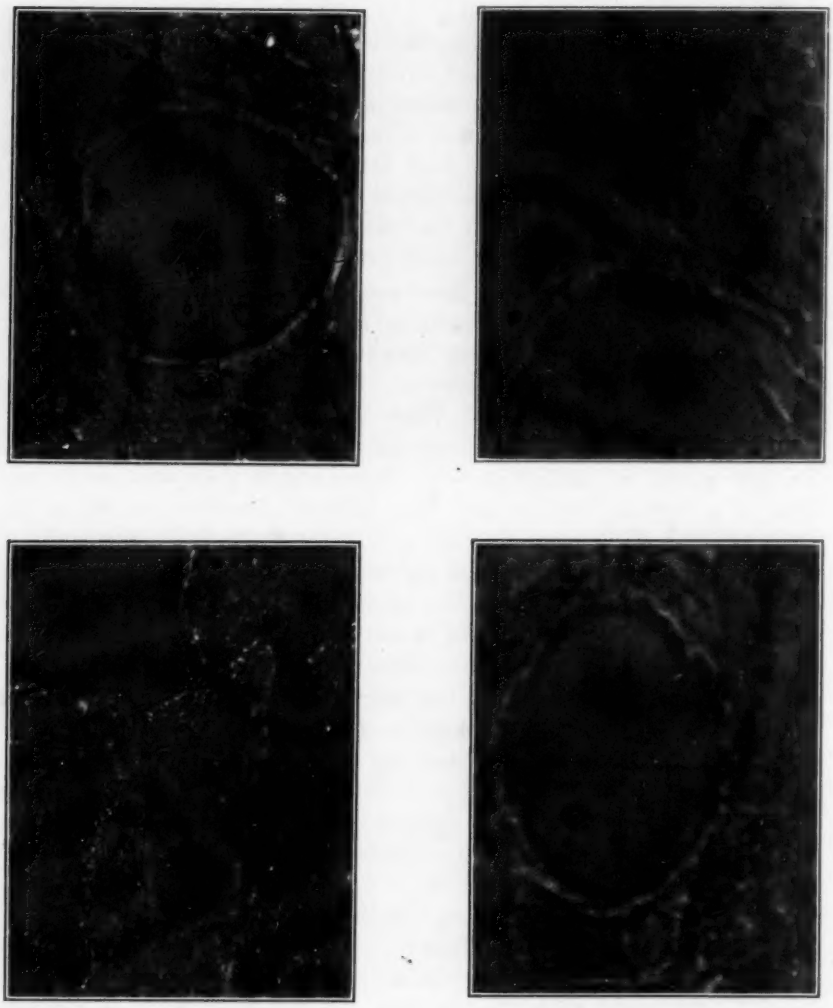


FIG. 2.

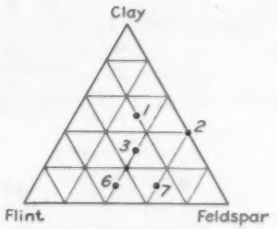
retardation of the growth might be due to equilibrium having been established to a degree obtainable under those conditions, and that the aluminous spots resulting from the clay particles had been entirely transformed.

Further heat treatment dissolves quartz faster than mullite. The glass, becoming so much richer in silica, may be the cause of decreased strength and decreased resistance to thermal change.

The Physical Properties of Porcelain

It has been repeatedly pointed out that a porcelain having a low coefficient of expansion is desired for resistance to thermal shock but it would seem that the statement should be modified slightly to include a specification of mechanical strength. The process described above, lowered the coefficient of expansion of a porcelain but, as has been said, reduced the mechanical strength with this increased fire and solution. Handrek[3] has found that quartz solution and content of other crystalline constituents is not a criterion of porcelain value.

It is well known that vitreous porcelain fired too hard but not overfired, has a lower coefficient of expansion than one softer fired. Its strength, however, is usually lower and is apparently sufficiently weakened so that it cannot stand the stress imposed upon it in fast temperature reversals even though having a reduced coefficient of expansion. That is to say, the coefficient of expansion has decreased but the mechanical strength has decreased at a still greater rate.



BODY	1	2	3	6	7
CLAY	50	40	30	10	10
FLINT	20	–	30	50	30
FELDSPAR	30	60	40	40	60

FIG. 3.

As a result of this it can safely be said that the mechanical strength of the body has as much or more to do with the thermal resistance of a porcelain than does its coefficient of expansion. This has been found true in glass also and it has resulted in the development of the Winkelmann and Schott formula which gives a value for the resistance of a glass whose properties are known to thermal change. It is as follows:

$$W = \frac{T}{a \cdot E} \cdot \sqrt{\frac{C}{S \cdot G}}$$

T = tensile strength
a = coefficient of expansion
E = modulus of elasticity
C = thermal conductivity
S = specific heat
G = specific gravity

It may not be out of the question to claim great similarity of porcelain to glass and attribute considerable to the glass portion for the porcelain's properties.

Microscopic Studies

The foregoing may be noted indirectly in a microscopic study of the clay-flint-feldspar diagram. (See Fig. 3.) Unfortunately the following

[3] *Keramos*, **7** [13], T5 (1928).

petrographic study has not been tied in with mechanical strength, coefficient of expansion, and heat shock data but it does make the possible effects of glass composition apparent. For instance, Body 1 is a typical clay-flint-feldspar porcelain. Its mullite development at cones 10 and 12 is much more pronounced than it is in Body 2. The same is true of Body 3 even though the latter is poorer in clay than 2 or 1. There is also a very marked contrast in the mullite contents of Bodies 6 and 7. Body 6 is distinctly rich in mullite development whereas Body 7 is distinctly poor or lacking in mullite development at cone 10, cone 12, and cone 15. One would expect greater mullite development in Body 1 than in Bodies 2 or 3 on the basis of greater clay content but the greater mullite development in Body 6 over that in Body 7 can be attributed to viscosity or solution of the mullite in the feldspar glass. If this is true, the observations noted concur with those of Schwartz and Merk to corroborate this mullite solubility. The above will then probably account for the disappearance of mullite in a feldspar crystal incident upon the overfiring process. The rate of solution of the mullite as well as that of the quartz in such a complex system should be considered in a study of body characteristics.

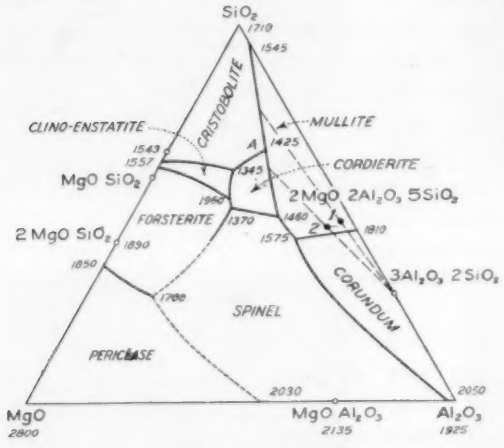


FIG. 4.—The system MgO–Al_2O_3–SiO_2, Rankin and Merwin, *Amer. Jour. Sci.*, **45**, April, 1918.

It will be admitted by most of us that a difference of 10% flint makes a radical difference in the characteristics of a porcelain body.

As has been noted in the clay-flint-feldspar bodies, a variation of the flint content seriously affects the nature of the body. The resulting system in that case is, of course, heterogeneous and the difference in characteristics results from physical as well as chemical conditions.

The conditions existing in the MgO–Al_2O_3–SiO_2 system are also typical of what might occur. (See Fig. 4.) To what extent the phenomena take place depends on various conditions but we can use this for example.

Body 1 varies from Body 2 only to the extent of 4% MgO. Body 1 contains 2% MgO whereas Body 2 contains 6% MgO. If we begin to fire either composition using common ceramic materials such as talc, clay, flint, magnesite, etc., rather than the compatible phases, the 1345°C

eutectic will melt first, and equilibrium conditions would be established if sufficient time were permitted. Further temperature increases melt these two phases until at point A three phases are in equilibrium. In case of Body 1 silica is in excess and would carry the melting process up the silica-mullite boundary. If the process were stopped, the bonding glass would be siliceous supercooled liquid. Body 2, however, richer in MgO, follows up the mullite—$2MgO$, $2Al_2O_3$, $5SiO_2$ boundary as melting proceeds. If the firing process is stopped above point A, the bonding glass would obviously be radically different from that of Body 1. To be sure the crystal structure of each is different, but the glass phase is the bonding medium and ought to have greater consideration in our porcelain studies. All of this goes to show that small changes in composition may seriously affect the crystal and glass compositions or the crystal and glass ratios, both of which seriously affect the porcelain properties.

Conclusions

Through the above it is hoped that the following points have been proposed for more serious consideration in porcelain studies:

(1) That mullite and quartz solution may contribute to the weakening of porcelain with excessive fire.

(2) That mullite or quartz solution contributes to the lowering of the resistance to thermal shock in spite of lowering of the coefficient of expansion.

(3) That the character of the porcelain is dependent as much or more upon the character of the bonding glass as upon the crystal structure.

(4) That small changes in chemical composition may make vital changes in the physical conditions of the glass as well as large differences in the constitution of the body.

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STUDY OF THE PROPERTIES OF SIMPLE ENAMEL GLASSES[1]

By A. I. Andrews

ABSTRACT

Three component glasses of the systems Na_2O–B_2O_3–SiO_2 and Na_2O–PbO–SiO_2 were investigated as to acid-resisting properties. An increase in silica in general improves the acid resistance. The effect of Na_2O, B_2O_3, and PbO on the acid resistance of an enamel is dependent on the composition to which these oxides are added. Some of these enamels showed considerable promise as acid-proof enamels.

Introduction

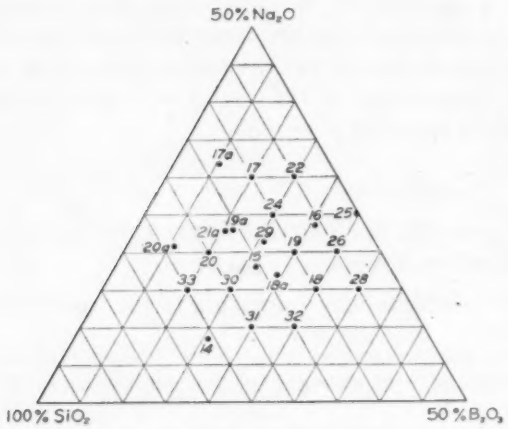

FIG. 1.—Cast iron: Na_2O–Ba_2O_3–SiO_2.

In a research on the development of acid-resisting dry-process cast iron enamels, a study was made of the relations between the composition and the properties of simple enamel glasses. The present paper deals only with these glasses and does not touch on the further development of acid-resisting enamels.

All enamels contain silica, the alkalis, and either boric oxide or lead oxide. These oxides were therefore chosen as those upon which to base a fundamental study. In this investigation two three-component (triaxial) diagrams were constructed, one having at the apices of the triangle sodium oxide, boric oxide, and silica and the other sodium oxide, lead oxide, and silica. These diagrams are shown in Figs. 1 and 2, respectively, and represent all possible com-

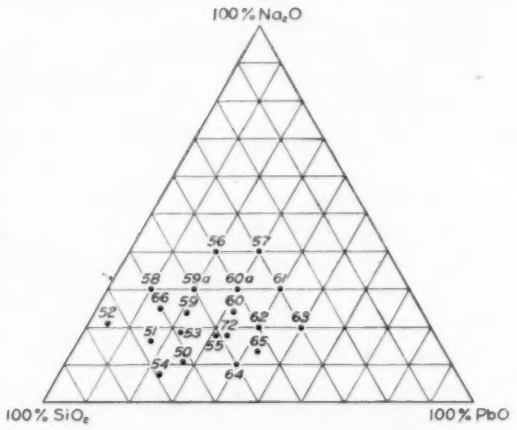

FIG. 2.—Cast iron: Na_2O–PbO–SiO_2.

[1] Presented at the Annual Meeting, American Ceramic Society, February, 1929, Chicago, Ill. (Enamel Division.)

binations of the oxides in question. The compositions of the enamel glasses actually made are represented by dots on these diagrams and the number over the dot represents the serial number identifying the composition.

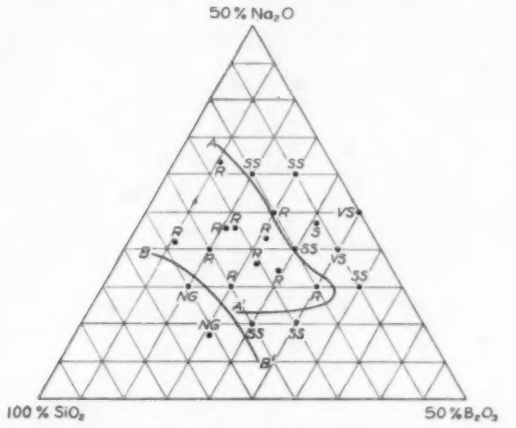

FIG. 3.—Cast iron: Na_2O–B_2O_3–SiO_2. Citric acid spot test. *R* = acid resisting; *SS* = slightly soluble; *S* = soluble; *VS* = very soluble; *NG* = too refractory.

Procedure

These enamel glasses were made up by the ordinary laboratory method. The raw materials were well mixed and smelted in five-pound batches in crucibles heated in pot furnaces. The molten smelt was quenched by pouring into cold water, after which it was dried and ground to 100-mesh in porcelain ball mills. The enamel glasses were applied by dusting the 100-mesh powder onto the hot cast iron to which a ground coat had already been fired. The dusted test piece was then returned to the furnace and melted down to as good a glass as possible.

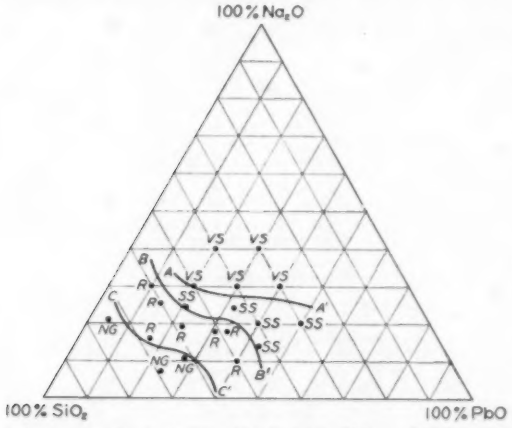

FIG. 4.—Cast iron: Na_2O-PbO-SiO_2. Citric acid spot test. *R* = acid resisting; *SS* = slightly soluble; *S* = soluble; *VS* = very soluble; *NG* = no good.

Results

Acid Resistance The results of this investigation are shown in Figs. 3 to 8. Figures 3 and 4 show the acid resistance of these enamel glasses as determined by the spot test using a 7% solution of citric acid (same as lemon juice). A drop of the citric acid solution was placed on the surface of the finished enamel and allowed to stay there for fifteen minutes. It was found that if an attack were going to take place at all, it would show up

in even less than fifteen minutes. The enamel glasses which did not show any sign of attack were marked *R* indicating that they were acid resisting. Those showing a slight iridescence or faint attack were marked with an *SS* indicating a slight attack; those showing a decided etching or a loss of gloss were marked *S* indicating solubility and those having a severe etched surface after the test were marked *VS* indicating that they were very soluble. These same symbols are used on the diagrams, the different areas being marked off with curved lines, *AA'*, *BB'*, etc. Compositions marked *NG* were either too refractory or for some other reason could not be worked.

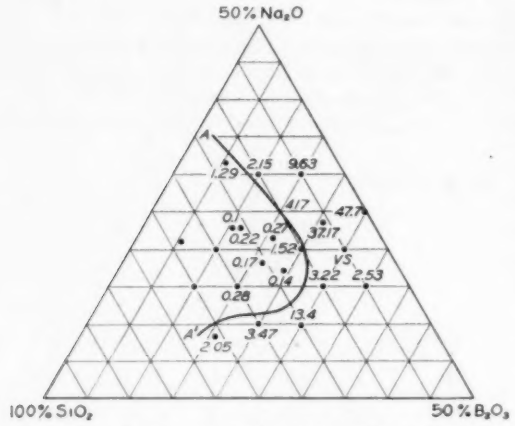

FIG. 5.—Cast iron: Na_2O–B_2O_3–SiO_2. Grain test (HCl). Per cent soluble in constant boiling hydrochloric acid at 100°C for 3 hrs.

Figures 5 and 6 show the results of the grain test on the acid resistance of the different enamel glasses. The figures over the points representing the compositions indicate the percentage soluble based on the original weight of the sample. The test consisted of subjecting a fifty-gram sample of 20- to 30-mesh enamel frit to the action of constant boiling hydrochloric acid at 100°C for three hours. The sample was then filtered off, dried, and re-weighed, the loss being calculated as the per cent soluble. These results are in agreement with those obtained by the spot test and are, therefore, a check on them.

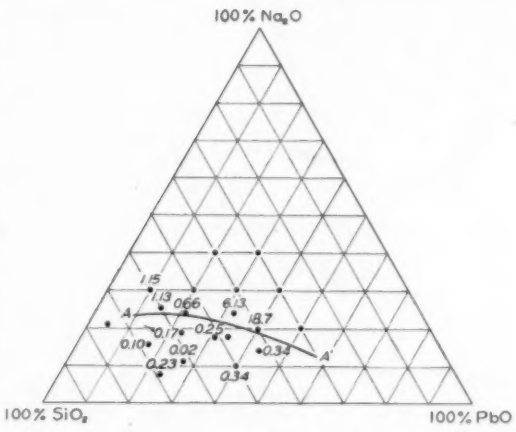

FIG. 6.—Cast iron: Na_2O–PbO–SiO_2. Grain test (HCl). Constant boiling hydrochloric acid at 100°C for 3 hrs.

General Qualities Figures 7 and 8 show the general characteristics of the enamel glasses other than the solubility and opacity. Composition 64 is quite opaque, but the other compositions are translucent to transparent. The glasses marked *OK* show promise of being developed into good enamels, those marked *Z* are crazed, those marked *C* are chipped, those marked *B* are blistered, those marked *X* crawled, those marked *NG* are too refractory, and those marked *D* have several defects. Again curved lines are drawn on the diagram to separate the defective enamels into groups.

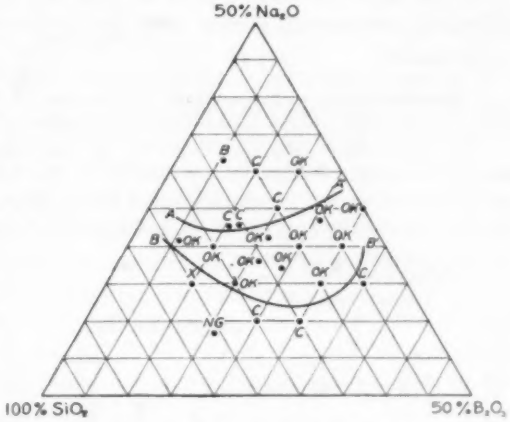

FIG. 7.—Cast iron: Na_2O–B_2O_3–SiO_2. Defects. *NG* = too refractory; *C* = chipped; *Z* = crazed; *B* = blistered; *X* = crawled; *D* = several defects.

Upon the addition of tin oxide to these enamels some of them showed considerable promise without further modification. Composition 72, for instance, containing 13% of tin oxide is workable and acid proof. It is not attacked by strong hot hydrochloric acid after days of exposure.

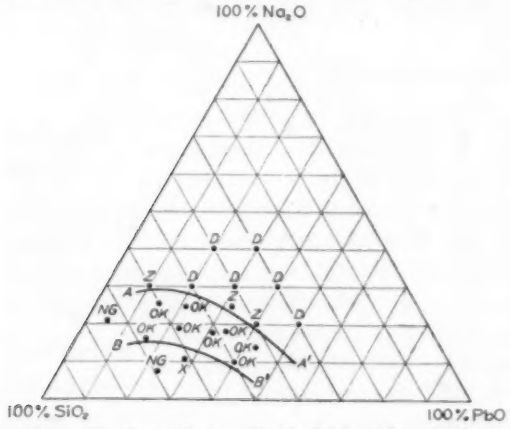

FIG. 8.—Cast iron: Na_2O–PbO–SiO_2. Defects. *NG* = too refractory, *C* = chipped; *Z* = crazed; *B* = blistered; *X* = crawled; *D* = several defects.

General Summary of Results and Conclusions

(1) Simple enamel glasses can be made and applied to cast iron by the dry process.

(2) Simple enamel glasses can be made into fair enamels by the addition of tin oxide as an opacifier.

(3) An increase of silica in general improves the acid resistance, but in some cases this does not appear to be true. This may be due to the fact that the enamel glass is not thoroughly fused when high silica is present.

(4) The effect of soda, boric oxide, and lead oxide on the acid resistance of an enamel is dependent on the composition to which these oxides are added.

(5) An acid-resisting enamel is obtained by the proper proportion of different constituents rather than by the increase or decrease of certain constituents.

Acknowledgment.—This research was conducted by the Engineering Experiment Station of the University of Illinois under the administrative direction of M. S. Ketchum.

The writer wishes to acknowledge the financial support of the Bureau of Cast Iron Enamel Research. He also wishes to thank C. W. Parmelee for his helpful suggestions and aid in this work. In appreciation of the laboratory aid he wishes also to acknowledge the conscientious work of W. N. Noble and E. F. McDonald.

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THE DETERMINATION OF AIR IN PLASTIC MIXES[1]

By Vance Cartwright[2]

ABSTRACT

This article describes a laboratory procedure for the determination of air in wet clay mixes.

Introduction

During the process of manufacturing ceramic materials from plastic clay mixes, a certain amount of air is undoubtedly entrapped in the clay mix. Very little laboratory work has been done to show the quantity actually present. It is the object of this article to describe a simple, accurate method by which such results may be obtained.

H. Spurrier pointed out that by vigorously boiling a sample of clay in water, the air could be liberated quantitatively. On that assumption he devised two pieces of apparatus for its determination.[3]

An attempt was made in this laboratory to use these devices, but difficulties developed. The first was awkward to manipulate because of the necessity of inclining it at an angle of 100° to allow the burette to fill. Leakage of air into the apparatus was a constant annoyance. The successive use of kerosene and water caused the formation of a black scum that clung to the burette and made it impossible to read the meniscus closer than 0.2 cc.

The simplified Spurrier apparatus worked more satisfactorily although it was not designed for accurate work. The greatly improved apparatus described in this article has been developed with the help of suggestions by fellow-workers.

Method Employed

Boiling of Sample Separation of air and clay is caused by boiling the sample in water in a container sealed at the bottom with mercury. The volume of air is measured in a gas burette so arranged that a definite temperature and pressure can be applied. The apparatus requires no tilting and contains only one rubber connection so that no trouble from leakage is encountered. An added advantage is that kerosene is not used in the determination.

Description of the Apparatus The apparatus is presented in Fig. 1 and consists of three parts: a de-airing burette, A, a flask to hold a boiling supply of de-aired water, F, and a gas-measuring burette, C. The burette, A, is jacketed to prevent steam forming in the column above the side connection, D, during boiling. A reflux condenser is attached to the flask, F, so that the de-aired water will not be lost

[1] Received January 5, 1929.

[2] Industrial Fellow, Refractories Fellowship, Mellon Institute of Industrial Research.

[3] *Jour. Amer. Ceram. Soc.*, **1**, 710 (1918) and **2**, 490 (1919).

through vaporization. The leveling bottle, H, is used for measuring the air under atmospheric pressure.

Procedure The first step is to provide the necessary water. The flask, F, is filled with tap water and brought to a boil as quickly as possible. Water is turned on so that the jacket of the reflux condenser is cooled. The upper end of the condenser is left open so that pressure will not build up inside. One and one-half to two hours' vigorous boiling will cause the air content to be reduced to 0.20 or to 0.25 cc. per blank sample of about 250 cc. It will remain fairly constant within those limits as long as boiling is continued.

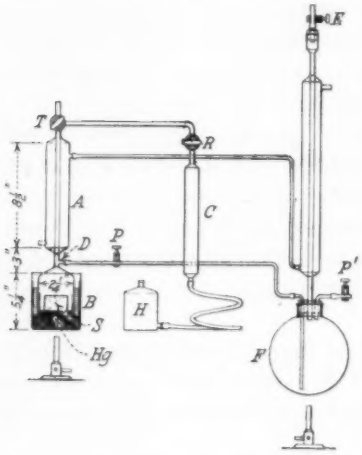

FIG. 1.—Apparatus for determination of air in plastic clay mixes. (Note rubber connection between T and R.)

The blank determination is next made. A 250-cc. beaker, B, with about one inch of mercury in the bottom is clamped in place so that the lower edge of the bell of A is very slightly above the bottom of B. Water is poured into the annular space between the bell and B to prevent escape of poisonous mercury vapor. C and the horizontal connection to A are filled with air-saturated water from H by raising the bottle and opening R and T to allow the air to escape. A is filled next. To do this E is closed and the screw clamps, P and P', are opened. By blowing air in at P', de-aired water is forced to fill A up to T. The contents of A are heated to boiling by a burner under B. It will be noticed that bubbles of steam will oscillate up and down in the stem between the bell and the junction of the stem and water jacket. The heating should be slowed when this occurs so that there is no danger of the apparatus being filled with steam. Ten minutes' boiling is usually sufficient to allow a complete liberation of air. A black scum sometimes forms in the top of A and in order to read the volume accurately it is necessary to remove it. This may be accomplished by drawing the air back and forth through the connection between A and C several times. By proper manipulation the scum can be caused to sink in the de-airing burette, leaving a clear meniscus to be read in C. The volume of air in the gas burette should be read immediately or re-solution may occur. The volume is read to the nearest 0.1 cc. and estimated to the hundredths.

A determination on a sample may next be carried out. A cube is

shaped at some definite pressure, weighed to the nearest 0.1 gram, and placed in the beaker on the mercury. A is filled as quickly as possible so that the sample will not have time to slake and lose air. When the determination is complete, the volume of air is read. The mercury can be separated from the water and clay by first pouring it through a screen to remove the coarse particles and then through a separatory funnel.

It is well to keep a slightly negative pressure inside A during a determination so as to facilitate the liberation of air. An aspirator or vacuum line may be arranged to pull through the reflux condenser and the side connection D to A, but this requires constant attention to prevent the contents of A being sucked into the flask, F. A more simple method is to lower F until the difference in level between the mercury inside A and in the annular space is sufficient to provide the pressure desired. Usually a half-inch is adequate.

For purposes of comparison, results are expressed in cubic centimeters of air per hundred grams of dry clay. The volume read at the end of a determination, the weight of the sample, the blank correction, and the water content of the sample are sufficient data to calculate the result. The water content may be determined by drying one or two cubes such as are used in the air determination.

Effect of Surfaces In making a series of determinations on different mixes it is well to keep in mind the effect of surfaces. The minute holes on the surfaces of a sample undoubtedly hold a certain amount of air which will appear in the results as entrapped air. Since rough surfaces will hold more than smooth ones, an effort should be made to smooth the sample before it is used. No method for completely eliminating the error has been developed. For comparative data on the same mix, samples can be made as nearly as possible the same shape and size and the error will be practically constant. Where different mixes are used, however, a smooth impervious coating would be desirable.

Calculation of Results To provide a comparative basis for results the cubic centimeters of air per hundred grams of dry clay were adopted. The following formula is used to calculate the results:

Let W = wet weight of sample
V = volume of air in sample
P = water of plasticity
v = volume of air in blank
Then $V-v$ = correct volume of air

$$\frac{(100)\ (V-v)}{W(100-P)} = \text{volume of air/100 g. dry clay}$$

The following data show the variations to be expected in the results obtainable from the apparatus. In estimating the error it must be re-

membered that the samples were small, the volume of air low, and that the distribution of air is not uniform throughout the mass.

Sample	Wet weight sample (grams)	Water plasticity	Volume of air (cu. cm.)	Corrected volume of air (cu. cm.)	Vol./100 g. wet sample (cu. cm.)	Vol./100 g. dry clay (cu. cm.)
A	103.5	18.06	1.10	0.94	0.91	1.11
	101.3	18.06	1.17	1.01	1.00	1.22
B	105.7	13.26	1.94	1.74	1.64	1.89
	104.4	13.26	1.72	1.52	1.45	1.67
C	97.8	15.00	1.60	1.45	1.48	1.74
	96.9	15.00	1.60	1.45	1.49	1.75
D	105.6	12.57	0.57	0.37	0.35	0.40
	102.9	12.57	0.53	0.33	0.32	0.36
E	102.5	12.98	1.70	1.50	1.46	1.67
	101.5	12.98	1.65	1.45	1.43	1.64

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STATISTICAL AIDS IN LOCATING POTTERY TROUBLES[1]

By W. Keith McAfee

ABSTRACT

The importance of performance records in pottery production and the advantages of arranging performance data in proper time relationship are pointed out. An outline of pottery record system is appended.

Introduction

Statistical records and analyses are not in themselves a substitute for management or foremanship. No matter how elaborate a system of records a manufacturing plant may compile, it is still just as necessary for superintendents and foremen to keep in constant touch with the results of the labors of their workmen. On the other hand, statistics of factory performance are invaluable to executives who must keep in touch with manufacturing results with the minimum expenditure of time. The importance of statistics from this point of view increases as a function of the size of the factory organization.

Due to the variation of the raw materials used, and the lack of adequate technical knowledge and control, the pottery industry, together with most of the ceramic industries, experiences comparatively high manufacturing losses. Consequently, estimates of future performance must be made from records of past and current performance and these estimates used as the basis for production control.

The human mind is very prone to remember most vividly what it has last acquired. For example, if 10% of the ware drawn from the kiln the first part of a week is dunted and this drops to 5% Friday and Saturday, the superintendent and his foreman will have a much more complacent point of view about it if the fact that the dunted ware the previous several weeks had been 1% is not clearly brought to their attention. One of the important functions of factory records is, then, to integrate performance over definite time-intervals. The length of the interval, whether days, weeks, or months, is determined by a study of each particular case.

Inasmuch as the manufacturing cycle is long in the pottery industry, it is difficult to correlate data in their proper time relationship. Minor happenings may turn out to be most important as a cause of trouble. Consequently all possible data, consistent with their cost of collecting, should be kept, even though they are not regularly used. Since pottery performance is often kaleidoscopic in nature, the record system must be flexible and, more important still, the management and statistical department must be flexible enough to adapt themselves to changing conditions.

[1] Received January 9, 1929.

System Used

The particular system of records referred to below has been in use, in its present form for about two years in a pottery manufacturing vitreous china sanitary ware. In order to illustrate the process in this factory a flow diagram is shown in Fig. 1. Six major control points are indicated. The first two are supervised by the laboratory and the remaining four by the inspection department. The heads of these departments report to the manager and occupy positions on a par with the superintendent.

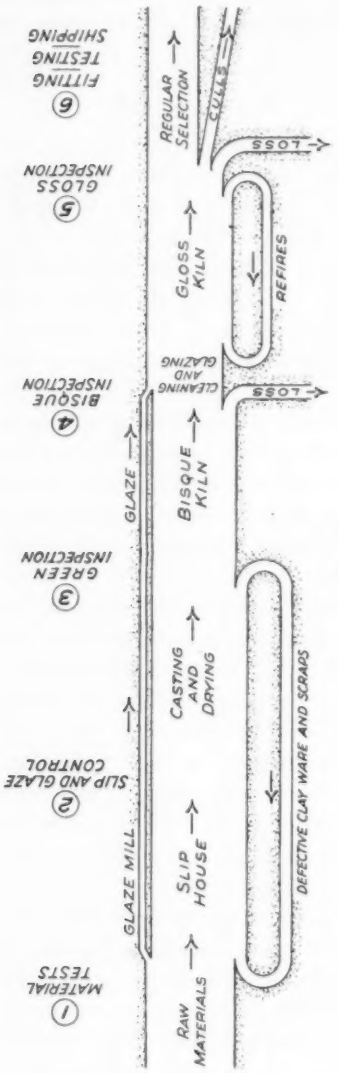

FIG. 1.

A detailed list of the manufacturing operations is given in Appendix I, together with the form of report from which the performance records are compiled.

In order to summarize in proper time relationship the data compiled, many of them are entered on the chronological chart. Each sheet covers the period of one month. Three are fastened to a drawing board at one time overlapped at the top so that the heading on the upper sheet serves for all three and the first day of each succeeding month follows directly below the last day of the previous month. The lower or third sheet is always for the current month and the other two sheets are thus for the preceding two months. Average time-intervals are indicated by diagonal lines which thus follow through from one month into the next. Tunnel kilns are used for both firing operations. The production is so planned that there is a steady flow through all operations and the working inventory is kept at a minimum. Thus the task for the bisque kiln placers is the casting shop production of ten days before, less the ware rejected by the green inspector; and similarly, the task for the gloss kiln placers is the bisque ware drawn the day before, less the bisque kiln loss or broken ware. In

other words, there are no points where ware is side-tracked or held up in normal operation, and the average time-intervals shown obtain fairly accurately.

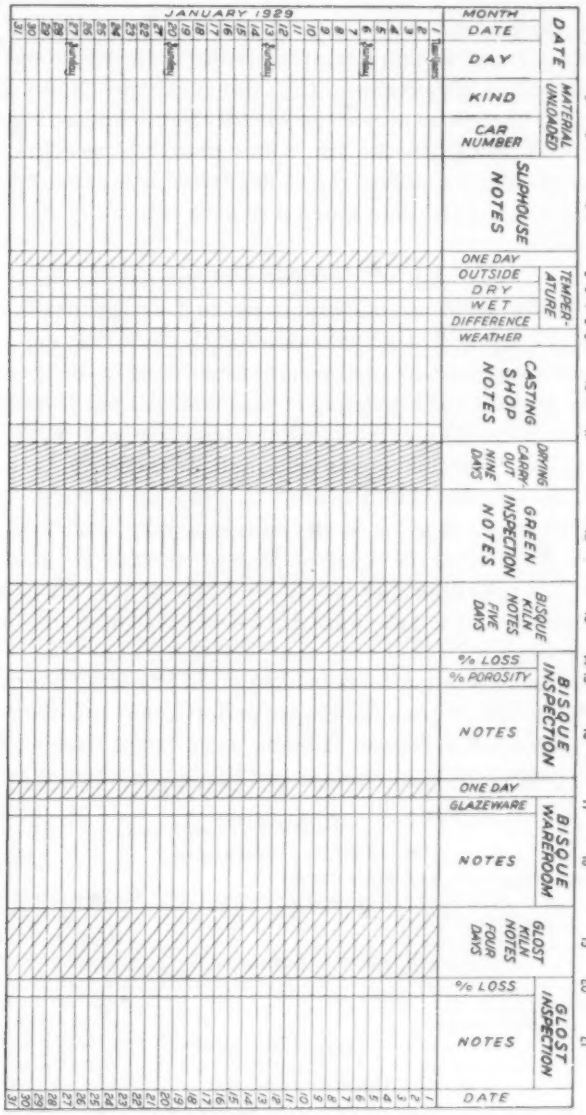

FIG. 2.

If some unusual trouble develops in the gloss ware, for example, on the 25th of the month, it would be entered under Gloss Inspection Notes (Column 21) for that date, and by tracing back the average time-interval

lines it would be evident that the ware was probably processed through the bisque wareroom on the 21st. The reports entered of glaze specific gravity (Column 17), dipping room temperature, or unusual behavior on that day (Column 18) would be studied as well as any abnormal conditions in the kiln which would have been entered in Column 19. If no probable explanation is found in this department, the next step would be to trace back to the bisque inspection on the 20th (Columns 14, 15, and 16), and so on back to the green inspection on the 15th, the casting shop on the 6th, and the sliphouse on the 5th. Raw materials received just prior to this time might also be suspected and their test cards carefully studied.

An explanation of the data entered in each column of Fig. 2 is given in Appendix II.

Conclusions Derived

Among the interesting conclusions reached as the result of using the chronological chart for about two years is the fact that certain clays formerly thought essential to good results were found to be actually harmful in the body formula; the grinding of flint and feldspar is quite important; variations in successive cars of clays seldom cause trouble although at times they do; weather conditions, and particularly casting shop air conditions, have an important bearing on breakage of ware; troubles from raw materials may not show up in the bisque kiln but yet have a marked effect in the gloss kiln; the aging and temperature of the glaze slip are important for the particular glaze used; and finally, that a ring made from a horseshoe nail should not be warn by a laborer temporarily drawing ware from kiln trucks.

The more basic result was the education of the supervisory force in the relationship of the various factors to performance and their relative importance. This is, of course, valuable even when nothing can be done about it, because it at least tends to put the blame where it belongs.

Appendix I

List of Operations

(1) Raw materials	(*a*) Place order	
	(*b*) Notice of shipment	Make out test cards A, B, and C. A and B to receiving clerk, C to laboratory
	(*c*) Receipt of material	Receiving clerk fills in data on A and B and notifies laboratory to break seals and get samples. Sends B card to labor foreman who unloads the car
	(*d*) Unloading material	When material is unloaded labor foreman returns B card to receiving clerk who enters date unloaded on A card and forwards to main office. Forwards B card to laboratory

	(*e*)	Test of material	Laboratory enters received and unloaded dates on C card
	(*f*)	Acceptance of material	Results of test entered on B and C cards. C card filed by material, B card forwarded to main office
(2) Body preparation	(*a*)	First slip	Number of blungers first slip loaded and unloaded (daily report)
	(*b*)	Filter press	Number of presses pumped and unloaded (daily report)
	(*c*)	Second slip	Number of blungers second slip loaded and unloaded. Weight of each electrolyte for each blunger (daily report)
	(*d*)	Pump to storage	Any unusual circumstances and any changes (daily report)
(3) Glaze preparation	(*a*)	Grinding	Mills filled and emptied (daily report)
	(*b*)	Delivering	
(4) Mold preparation	(*a*)	Modeling	Daily time slips for time and plaster used and charge
	(*b*)	Blocking	"
	(*c*)	Casting	"
	(*d*)	Mold making	"
(5) Sagger shop	(*a*)	Making grog	
	(*b*)	Making soaks	Daily time slips give number put up
	(*c*)	Making saggers	Daily time slips for number and kind
	(*d*)	Delivering to kiln	"
(6) Green department	(*a*)	Sale of tools	Bi-monthly report
	(*b*)	Casting	Daily time slips give number and kind subject to correction by bi-monthly inventory. Temperatures, weather, mold conditon, etc., by daily report
	(*c*)	Carry out	Daily report by green inspector
	(*d*)	Inspection	"
(7) Bisque firing	(*a*)	Car repairs	Record by date and car, kept by foreman
	(*b*)	Placing ware and saggers	Daily time slips for payroll. Manifold of kiln car card to office for record of number and kind
	(*c*)	Kiln reports	Daily report of kiln readings and charts from recording instruments
	(*d*)	Drawing ware and saggers	Daily time slips for payroll, kiln car cards forwarded to inspector for 8*a*
(8) Bisque department	(*a*)	Inspection	Fills in kiln car card for record and sends to office. Daily report for superintendent and for Loss by Date Cast report
	(*b*)	Cleaning and stopping	Daily time slips

	(*c*) Dipping	Daily time slips. Daily report of glaze weight, etc.
(9) Gloss firing	(*a*) Car repairs	See 7*a*
	(*b*) Placing ware	See 7*b*
	(*c*) Kiln reports	See 7*c*
	(*d*) Drawing ware	See 7*d*
(10) Gloss department	(*a*) Inspection	See 8*a*
	(*b*) Fitting	Daily time slips
	(*c*) Testing	Daily report
	(*d*) Shipping	Shipping orders entered and returned to office

Appendix II

CHRONOLOGICAL CHART (FIG. 2)

Column 1 Month and year, Sundays and holidays indicated in proper places.

Column 2 When shipping papers are received from supplier, accounting department makes out test cards in triplicate (A, B, and C) giving all data available. A and B are sent to receiving clerk, C to laboratory. When material is received, laboratory is notified to break car seals and take samples. When car is unloaded, date is noted on A and B cards by receiving clerk who forwards A card to main office and B card to laboratory. Material and supplier are entered in Column 2 on date unloaded. From B card, laboratory transfers date unloaded to C card and when tests are completed, enters results on both B and C cards, returning B card to main office and retaining C card for its files. If tests are satisfactory, a check is made after the shipment noted in Column 2. If unsatisfactory, an X is made. The B card is filed in main office according to date unloaded so that ready reference can be had in the future for explanation of the X mark.

Column 3 The initials and car number are entered from the A card referred to above. In case of less carload shipments, LCL is entered.

Column 4 Slip house foreman renders daily report of number of batches of first and second slip produced; number of filter presses pumped and taken off; number of pounds of each electrolyte used in each batch; any changes or unusual happenings. From this is entered in Column 4 number of pounds of each electrolyte used in each finished slip batch and any changes or unusual conditions.

Column 5 Outside "in the shade" temperature at noon.

Column 6 Dry bulb temperature in casting shop at noon.

Column 7 Wet bulb temperature in casting shop at noon.

Column 8 Degrees depression of wet bulb temperature below dry bulb temperature as given in Columns 6 and 7.

Column 9 Average weather conditions as "Fair," "Rain," "Snow," etc.

Column 10 Data for Columns 5 to 10 come to office noted on back of chart taken from recording thermometer in casting shop. In Column 10 are entered: casting shop slip action, average mold condition, average setting up time for a typical kind of ware (in this case, a washdown water closet bowl), and the general experience in the shop that day.

Column 11 Each piece of ware is stamped with the caster's check number and the date cast, while it is being taken out of the mold. The daily reports of the bisque inspector and gloss inspector list broken ware by caster's number and by dates cast, so that they can be compiled and studied on either basis. These results are tabulated on a report called "Loss by Dates Cast." As soon as enough time has elapsed to be sure all ware cast on a certain date is through the factory, the lost (or broken) ware cast that day is entered in Column 11. These data lag about four weeks behind the others, but are very interesting in correlation with slip control data that have been entered in Column 4.

Column 12 Any green ware broken in handling is entered and any abnormal defects found by the green inspector and entered on his daily report.

Column 13 Any abnormal conditions noted on the daily kiln report are entered such as gas or power interruptions. Gas consumption is noted.

Column 14 Loss (or broken ware) as a percentage of bisque ware inspected. The grading of the ware and the condition of pyrometric cones is noted on the

kiln car card. These are totalled for the day and entered on the Daily Production Report, together with similar data from the gloss kiln and other production data. The per cent loss for closet bowls, tanks, and lavatories is entered in Column 14, one above the other.

Column 15 This column was included in the hope that the laboratory could develop a porosity test as an index of bisque firing. So far they have been unsuccessful, due to the extreme vitreousness of the body.

Column 16 Major defects reported on Daily Production Report are entered.

Column 17 Specific gravity of the glaze slip in the dipping tubs and as used in the spray guns is entered. This is obtained from a daily report together with the data for Column 18.

Column 18 Temperature of the dipping room and anything unusual noted on daily report.

Column 19 Same as Column 13, except that it refers to gloss ware.

Column 20 Same as Column 14, except that it refers to gloss ware.

Column 21 Same as Column 16, except that it refers to gloss ware.

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STOKER APPLICATION TO THE CAR TUNNEL KILN[1]

By Carl B. Harrop and Howard S. Orth

ABSTRACT

Presents arguments for use of mechanical stoker on continuous kilns. Describes first practical application of mechanical stoker to the car tunnel kiln used for ceramics and gives results.

Adaptability and History

The car tunnel type of kiln is fundamentally continuous in all its essential features and insofar as possible everything pertaining to its operation and handling should be of continuous or uninterrupted character.

Upon the basis of cost of fuel alone, solid fuel is in most instances the cheapest to use and therefore it is only natural that many manufacturers will prefer this to either gas or oil. To adapt solid fuel to the car tunnel kiln to greatest advantage, uninterrupted supply of fuel by mechanical stokers seems to be logical.

The idea of mechanical stoker application is not new and should work out very well, but because the normal amount of fuel burned in each fire box for about cone 10, is only about 45 pounds per hour, the stoker must be small and stoker manufacturers have not whole-heartedly recommended a stoker small enough to be applicable.

Several years ago the Square D Company installed a mechanical stoker on one of their power plant boilers in Detroit. The results attained convinced L. M. Hausmann, Works Engineer, that similar equipment could be advantageously applied to the car tunnel kiln then under consideration for their electric porcelain plant at Peru, Ind. The only problem seemed to lie in securing a stoker of small enough size. Laclede Stoker Company, St. Louis, finally offered a small stoker which seemed practical. No car tunnel kiln constructed in the United States for firing ceramics had ever been successfully equipped with mechanical stokers, hence no experience in this connection was available.

Stoker

The stoker was of the underfeed plunger type with center tuyère box and both grate bar and dead plate on either side for the final combustion of the coke. The Laclede underfeed stoker differs from other underfeed stokers in that it is designed and arranged so as to be readily removable from the furnace, the main stoker frame being mounted on wheels. In case of stoker failure, this eliminates possible kiln shutdown. Furthermore the tuyères and grate bars can be replaced through the furnace doors. This permits minor repairs being made in a short time with the stoker in operating position.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Heavy Clay Products Division.)

The main stoker structure carries the frames of both the ash pit and furnace doors, forming a simple compact unit in each furnace. This frame seals against a recess in the brickwork, making the front of the stoker flush with the furnace front. The furnace doors are tile lined and where exposed to high heat, the frame is air cooled.

A slotted, adjustable crank arm in combination with a double pawl and ratchet wheel gives a close minimum and maximum coal feed regulation. An eccentric on an overhead lineshaft actuates the crank arm through a pull rod. The flexibility of this mechanical combination provides uniform and independent control at each stoker.

FIG. 1.

The coal progresses from the stoker hopper through the ram case, into the retort, then up past the tuyères into the furnace, or combustion chamber. The primary air for combustion is supplied through the tuyères and the secondary air through the grates. This double control permits operating each furnace much like a gas producer and gives control of length of flame. These controls have not been as positive as desired and some changes are being made on them at this time.

Coal Handling Equipment

The coal handling equipment serving these stokers was designed by Mr. Hausmann. A steel drag conveyer operating transversely underneath the railroad siding carries the coal from hopper bottom cars to a bucket eleva-

tor. The elevator lifts the coal to the top of a concrete silo-type storage bin with a capacity of 150 tons of coal. When drawing on the storage bin, this same elevator is used to lift the coal from the bottom of the storage to a screw conveyer running across the top of the bin. The screw conveyer carries the coal from this point to hopper over the kiln. The delivery from the elevator is so arranged that the amount of coal going to the conveyer is under control, any surplus amount falling directly into the bin, the same as when the bin is being filled from a railroad car.

From the hopper over the kiln the coal is fed by gravity through spouts to all of the individual stoker hoppers.

Car Tunnel Kiln

The tunnel kiln, to which these stokers are applied is used for firing one-fire glazed and unglazed electric porcelain to cone 12. The kiln length is

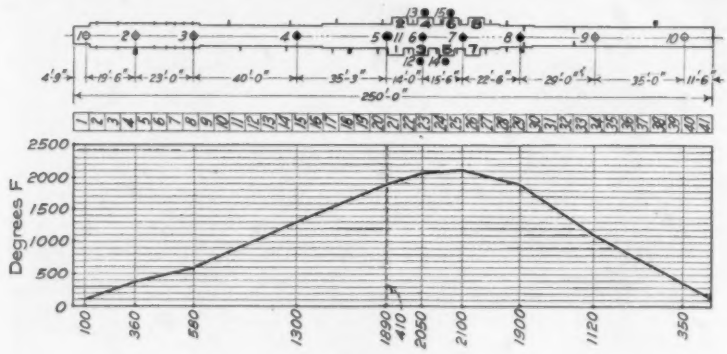

FIG. 2.

250 ft., the tunnel is 48 in. wide and $45^5/_8$ in. high. Sixteen cars (each 6 ft. long) are fired per 24 hours—each car carrying an average of 100 saggers, measuring approximately $12^1/_4$ x $16^1/_4$ x $4^3/_4$ inches high. This corresponds with a car charging schedule of 1 hour and 30 min. or a firing period of $25^1/_2$ hours and a cooling period of 15 hours.

The kiln is equipped with 8 stokers, 4 on each side, located 10 ft. on centers. Elkhorn (Eastern Kentucky), Mine No. 214, $1^1/_2$-inch run-of-mine screenings are used. The amount of coal burned in the 8 stokers is 7500 lbs. per 24 hours.

Covering the furnace section of the kiln and resting on the parapet walls is a sheet metal hood from which hot air is drawn and delivered by duct system for heating their new plant extension. In addition to this, the waste heat from the cooling end of the kiln is also distributed for plant heating purposes.

To take care of periods when the grates are being cleaned a sheet metal

hood is mounted over each stoker and connected to a duct system. This carries all smoke and furnace fumes through the roof to the atmosphere.

Conclusions

After a year's operation, it seems fair to draw the conclusion that the mechanical stoker is practical and very desirable in connection with continuous kiln operation. The year's experience, however, has clearly indicated that the stoker employed possessed some weaknesses, some of which have been remedied during the year, while others will be worked out in a new and heavier design which is being developed by the Laclede Company.

HARROP CERAMIC SERVICE CO.
310 W. BROAD ST.
COLUMBUS, OHIO

CLAY SEWERPIPE MANUFACTURE[1]

VI. Heat-Balance Determinations

By R. E. Arnold and George H. Duncombe, Jr.[2]

ABSTRACT

Heat-balance determinations were conducted on a number of sewerpipe kilns and the kiln efficiencies were found to vary from 14.97% to 29.03%. The method of calculating the heat balance is described in detail. Kiln efficiencies for individual periods range higher for the second period in most cases with some of the kilns reaching upward of 40% efficiency. In general as the kiln reaches higher temperatures the kiln efficiency decreases due to increasing stack and kiln structure losses. In all, thirty-four kiln tests were conducted in six plants in various sections of the country, in twenty-six of which heat-balance calculations were made, the remainder being auxiliary tests giving only general operating data such as tonnage of ware, fuel consumption, temperature schedule, and ware analysis.

I. Introduction

The round downdraft kiln is flexible, and therefore readily satisfies such a diversified product as clay sewer pipe. There is some promise of the acceptance of other firing equipment which may prove successful, but until the application of such equipment has proved superior by experimentation the round periodic kiln will hold the stage.

As a part of their program of research the Eastern Clay Products Association and the Clay Products Association approved an extensive kiln investigation[3] which began in the fall of 1926 and ended in the spring, 1928. This program was intended to develop fundamental design and manipulation factors with a view to increasing the efficiency of the periodic kilns in common use in the industry.

In all, thirty-four kiln tests were conducted in six plants in various sections of the country, in twenty-six of which heat-balance calculations were made, the remainder being auxiliary tests giving only general operating data such as tonnage of ware, fuel consumption, temperature schedule, and ware analysis.

The results of the investigation are of such magnitude as to make it difficult to present them as one comprehensive paper and for convenience as well as simplicity a series of papers written by the various members of the research organization have been arranged, of which this is the first.

The purpose of this paper is to outline the method of attack, the detail of test procedure, and the method of heat-balance calculation used in the investigation.

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[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Heavy Clay Products Division.)

[2] Industrial Fellows, Clay Products Association Industrial Fellowship, Mellon Institute, Pittsburgh, Pa.

[3] Conducted by R. E. Arnold (in charge), R. L. Blessing, E. A. Hertzel, H. C. Harrison, G. R. Pole, and C. E. Parmelee under the supervision of E. Ward Tillotson, Assistant Director at Mellon Institute.

II. General Consideration

Previous to the start of this program the investigation was much concerned with the selection of the heat-balance methods. The Bureau of Mines[4] kiln study for both the Four Heavy Clay Associations[5] and the Refractories Manufacturers Association[6] was the source of most of the methods used in this investigation.

As the purpose was to make comparisons in kiln design and manipulation and do this with variations in clays, fuels, draft conditions, and temperature requirements, the heat balance was decided upon as the only satisfactory means to disclose the fundamental principles involved. To lessen the effect of varying local conditions it was decided to divide the heat balance into five separate periods each of which constituted a separate heat-balance calculation. These arbitrarily chosen periods were based upon the top control temperature and were divided as follows:[7]

Periods	
1st	Start to 350°F
2nd	350 to 800°F
3rd	800 to 1400°F
4th	1400 to 1900°F
5th	1900° to Finish

The use of temperature-interval subdivisions was presumed to permit more detailed analysis of the results of alterations in manipulation or design particularly in the third and fourth periods. In some cases, the first, second, and fifth periods were influenced by clay requirements to an extent that obscured the results of proposed comparisons but in the third and fourth periods the effects of changes in time, draft, and other elements of manipulation, as well as type of fire box, flue system, and other elements of design, could be shown satisfactorily by means of heat-balance calculations.

In the first three plants comparisons were made on 36-ft. diameter kilns and in the last three plants they were made on 32-ft. diameter kilns. In all the plants the large ware was 24-inch D.S. pipe.

III. Detail of Test Procedure

The general procedure was similar to the reported work of the Bureau of Mines[4] but was altered to meet the requirements of the sewerpipe kilns.

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[4] W. E. Rice and R. A. Sherman, "The Determination of the Distribution of Heat in Kilns Firing Clay Wares," *Jour. Amer. Ceram. Soc.*, **7** [10], 738–63 (1924). (Considerable advice and assistance in developing the method used was obtained from W. E. Rice personally.)

[5] Burning Investigation of Four Heavy Clay Associations published privately.

[6] Problems in Firing Refractories, Bureau of Mines, *Bull.*, No. 271.

[7] Only two heat-balance calculations (see Footnote 4, and Henry N. Baumann, *Jour. Amer. Ceram. Soc.*, **10** [11], 860 (1927)) are recorded to the authors' knowledge in which the calculation was divided into periods, and both of these were divided with respect to time using 24-hour intervals as the basis.

The object of each test was to obtain complete data on the operation and the results from which comparisons such as have been previously indicated could be made. As the investigation proceeded changes in manipulation and design as suggested by previous results were incorporated in the program.

For each heat-balance test the procedure in selecting the data for computation and detailed information obtained was as follows:

(1) Ware Records Every kiln setting was carefully recorded as to number of stands, number of pipe high, and size of pipe set in the various locations throughout the kiln. The divisions of the kiln setting were: (1) pockets, (2) 1st, 2nd, etc., fire ring, (3) 1st, 2nd, 3rd, etc., ring of large pipe, (4) backout, (5) stuffing for fire ring, large pipe, and backout, and (6) corners for fire ring, large pipe, and backout. From these records the number of pieces of each size pipe was obtained.

During the setting at least 10 pieces from each size pipe were weighed and marked for identification. A sample of clay was also taken which represented the average setting. Percentage ignition loss (dry basis) was determined on this sample. The loss in weight of the ten marked pipe was also determined.

The following data were then calculated: (1) weight of clay, as set, and (2) weight of clay, as fired. The weight of clay (dry basis) was according to the formula:

$$\frac{\text{Wt. of fired clay} \times 100}{100 - \%\text{ ignition loss}} = \text{wt. of dry clay}$$

Also the weight of clay as set minus the weight of clay (dry) equals the weight of water in clay which was used in calculating heat lost by evaporation of this moisture. See Item (3) in the Section IV following.

(2) Fuel Measurements Fuel oil and natural gas quantities were determined by means of meters calibrated to measure volume. This volume was in cubic feet for gas and gallons for oil, both at a known temperature and pressure from which the weight calculation was made. Hourly readings were taken for both the gas and oil.

For coal firing, however, the fuel measurements were somewhat more complicated. A known amount of coal which was estimated to carry the kiln from the start to the nearest eight-hour reweighing time was placed about the kiln. At each firing the number of shovels of coal was recorded and summarized for the coal weighing period. At the end of the shift the residue fuel was reweighed and subtracted from the original supply set out. The weight of fuel for each firing was then calculated by dividing the number of shovels of fuel fired throughout the period into the total amount of fuel consumed, and then multiplying by the number of shovels fired at each firing.

A correction for moisture content was made for each shift by a moisture determination on a sample of the coal.

A sample of the fuel was taken for ultimate and proximate analysis, calorific value, and fusion temperature of the ash.

In order to determine the quantity of fuel which was considered to enter the kiln as a gas, a correction was necessary for the unburned fuel in the ashes. The ashes were weighed and a sample taken for the determination of the combustible material which was assumed to be carbon. The ash was allocated over the cycle to each period in accordance with the amount of fuel burned, thus obtaining a fixed deduction from each pound of coal fired.

(3) Temperature Measurement All temperatures in and around the kiln with exception of the outside atmospheric and kiln-wall temperatures were measured with a pyrometer system especially adapted for the purpose. With exception of a few control thermocouples a chromel-alumel thermo-element was used for each temperature position. Bare thermo-element, No. 18-gage wire, was used and brought to the outside of the kiln where it was attached to compensating lead wire. All compensating wire was led to a common point maintained at 32°F by ice and water. From this cold junction point copper leads were conducted to the field laboratory. A switchboard and the potentiometer were used for measuring the millivolts developed by each couple.

(4) Gas Composition Data A continuous stream of flue gas was obtained by suction and led from a water-cooled tube in the main flue into the field laboratory. A small portion of the sample was bubbled into a gallon sample bottle. The speed of flow of this portion was adjusted to approximately fill the sample bottle within the hourly or half-hourly period over which the analysis was desired.

Analysis for carbon dioxide, oxygen, carbon monoxide, and nitrogen by difference, was made with an Orsat apparatus.

(5) Quantity of Flue Gas The mols of flue-gas data were calculated from fuel consumption data and gas composition data according to the methods outlined in Item (6), Section IV.

(6) Pressures Static pressures throughout the kiln system were measured by the aid of an Ellison draft gage. Pressures thus obtained were below atmospheric. Static pressures were taken as a rule in the main flue, well-hole, secondary flues, paving course, and floor level. Iron pipe ($^1/_4$-inch diameter) was conducted from these points to the outside of the kiln and thence to the field laboratory by pressure hose.

(7) Log of Kiln and Control A record was kept of all changes made in the control of the kiln or any change in manipulation. The time, degree, and nature of the change was recorded.

(8) Kiln Drawing A working drawing was made of all the kilns on which a complete test was conducted.

(9) Watersmoking In an attempt to measure the rate of moisture removal from the ware in the kiln two pieces of the large size pipe were suspended, both top and bottom center of the kiln. These pieces were weighed hourly and the percentage weight-loss determined. Trouble was encountered in determining the end of watersmoking by this method as it was found that with some clays weight-losses were more or less continuous giving no indication of the point where it would be safe to advance the temperature rapidly.

NOTE: Decomposition of various minerals as well as the ability of the clay to hold on to the last traces of water may account for this condition.

(10) Miscellaneous Data Additional data was taken such as:

(1) Outside air temperature, pressure, and relative humidity.
(2) Draft distribution (by means of induction fan and anemometer).
(3) Ware analysis (No. 1 ware, serious defects, etc.).
(4) Cone temperature, glaze, strength, and absorption distribution from test pieces placed throughout the setting.

IV. Calculation of Heat Balance

For the computation of the heat balance for each period of the firing the following items were selected:

(1) Total heat input from fuel.
(2) Heat required to fire ware including rings.
(3) Heat in water-vapor in flue gas from moisture in ware.
(4) Heat in combustible in ashes.
(5) Heat in combustible in flue gas.
(6) Heat in dry flue gas leaving main flue.
(7) Heat in water-vapor in flue gas formed from fuel.
(8) Heat in water-vapor in flue gas from air entering.
(9) Heat in water-vapor in flue gas from moisture in fuel.
(10) Heat given up to kiln bottom and flues from floor to base of stack.
(11) Heat required to raise temperature of kiln walls.
(12) Heat required to raise temperature of kiln crown.
(13) Unaccounted for losses including radiation and convection.

Although in many instances the calculation of these items differed very little from the methods employed by Rice and Sherman,[4] it is considered advisable to submit them offering what changes were adopted as standard practice.

(1) Total Heat Input from Fuel The total heat input was found by multiplying the total number of pounds of dry fuel used during the period by the calorific value of a pound of dry fuel as determined by analysis.

$$H_1 = C \times A$$

where C = calorific value of fuel in B.t.u. per pound (dry basis)
A = number of pounds of fuel fired (dry basis)

(2) Heat Required to Fire Ware Including Rings The heat requirement for the clays of these tests was assumed to be equivalent to the values given by H. E. Simpson[8] on a Canton, Ohio, shale.

$H_2 = W(S_f - S_i)$
W = wt. of ware set (dry basis) in pounds
S_f = heat of summation at the average final ware temperature in B.t.u.'s per pound
S_i = heat of summation at the average initial ware temperature in B.t.u.'s per pound

NOTE: To obtain the necessary temperature data two couples were placed in a top 24-inch pipe, and two more were placed in a bottom pipe in the same stand. In each of these positions one of the couples was mudded against the outside surface of the barrel of the pipe and the head of the other was placed about 4 inches deep in a hole in the socket, and mudded. Readings of these couples were averaged to get the temperatures which were used to obtain the unit heat value from a curve prepared for the purpose.

This calculation was made for the total period.

(3) Heat in Water Vapor in Flue Gas from Moisture in Ware The heat lost by evaporation of moisture from ware is a function of the quantity of water in the ware and the heat required to evaporate the moisture and raise its temperature to that of the discharge at the base of the stack.

When considering the heat contained in the moisture in the flue gases it is essential to know the rate of removal of water from the ware, the initial temperature of the water at the start of the heat balance, and the temperature at which the moisture leaves the system.

The temperatures are measurable but the rate of removal is somewhat indefinite. The hourly moisture loss was determined from the rate of weight-loss from two suspended pieces, it being assumed that the moisture in ware left at the same rate. The amount of this heat was calculated hourly as follows:

H_3 = wt. of water removed in pounds times difference in heat capacity of water at the initial ware temperature and of steam[9] at temperature of gases leaving main stack flue.

(4) Heat in Combustible in Refuse The heat lost in the combustible in the refuse was obtained by multiplying the number of pounds of ashes removed times the percentage combustible in the ash times the calorific value of carbon burned to carbon dioxide. This calculation was made for the total period. When the ashes were not removed at the end of each period the calculation was made for the entire firing and the period allotment made according to the measured fuel.

[8] H. E. Simpson, *Jour. Amer. Ceram. Soc.*, **10** [11], 897–918 (1927).

[9] Marks and Davis, Steam Tables and Diagrams.

Heat capacity of steam at high temperatures were taken from molal heat curves given by Lewis and Randall in Principles of Thermodynamics, McGraw-Hill Book Co. Water was considered to be taken to 212°F and evaporated then curve values applied for vapor.

(5) Heat in Combustible in Flue Gas The heat-loss obtained from this source was calculated as follows:

$$H_5 = \frac{\%CO}{\%CO_2 + \%CO} \times \text{wt. of fuel fired (dry basis)} \times \%\ \text{carbon in flue gas per pound of fuel} \times \text{calorific value of CO burned to } CO_2 \text{ (which is taken as 10,200 B.t.u.).}$$

The $\frac{\%CO}{\%CO_2 + \%CO}$ value was averaged for each eight-hour shift or any fraction thereof and the calculation of heat lost by this item made on this basis. The eight-hour shift values were summarized for the period calculation.

(6) Heat in Dry Flue Gases Lost up Stack This heat loss was calculated from the following formula:

H_6 equals average number of mols of carbon dioxide gas per pound of carbon times pounds of carbon up stack times the difference in heat capacities[10] at the entering temperature of the air, and the temperature of the carbon dioxide leaving the system, plus average number of mols of diatomic gas per pound of carbon times pounds of carbon up stack times the difference in heat capacities at the entering temperature of the air, and the temperature of the diatomic gases leaving the system.

These calculations were made for each eight-hour period.

The data for calculating the mols of flue gas per pound of carbon are obtained from the gas analysis. The gas-analysis figures are given in per cent, but since according to Avagadro's hypothesis equal volumes at the same pressure of all gases contain the same number of molecules, this percentage figure is the same as number of mols per 100 mols. Then the pounds of carbon per 100 mols of flue gas from the carbon dioxide will be,

$$CO_2 \times 44 \times 12 \times \frac{1}{44}$$

(mols per 100 mols) (mol. wt.) (atomic wt. of carbon) (inverse of mol. wt. of carbon dioxide)

This simplifies to $12CO_2$.

Likewise for the pounds of carbon per 100 mols of flue gas from carbon monoxide the quantity of 12CO is obtained.

Then to obtain mols of flue gas per pound of carbon the following formula is set up:

$$M_{d.f.g.} = \frac{100}{12(\%CO_2 + \%CO)}$$

$M_{d.f.g.}$ = mols. of dry flue gas

$$= \frac{8.33}{\%CO_2 + \%CO}$$

Mols of carbon dioxide and diatomic gases were found by multiplying the average percentage of each for the 8-hour shift times the average mols of flue gas per pound of carbon up stack figured from each gas analysis.

[10] Haslem and Russel, Fuels and Their Combustion.

(7) Heat in Water-Vapor in Flue Gas Formed from Fuel Heat lost by this item is calculated as follows:

H_7 equals per cent H_2 in fuel times weight of fuel burned (dry basis) times 9* times difference in heat capacity of water at atmospheric temperature and of steam at the temperature of the gases leaving the system.

This calculation was made for each eight hours.

(8) Heat in Water-Vapor in Flue Gases from Moisture in Air Entering For this calculation the assumption was made that the total mols of flue gas equaled the total mols of air entering. The calculation was as follows:

H_8 equals number of mols of air entering times per cent relative humidity time number of pounds of water per mol of saturated air[11] times the difference in heat capacities[12] between moisture at the temperature entering and the temperature of the gases leaving the flue.

One calculation for each temperature period was made.

(9) Heat in Water Vapor from Moisture in Fuel The calculation was made the same as Item (7) except for the factor 9. The moisture in the fuel was determined by test.

(10) Heat Given up to Bottom by Gases from Floor to Base of Stack This calculation was separated into three divisions, namely, the heat given up by the carbon dioxide, the diatomic gases, and the water-vapor. The calculation was made by multiplying the mols of each of the gases times the difference in heat capacities for these gases at the temperature of the gases at the floor and at the base of the stack.

Values were obtained for each eight-hour shift.

(11) Heat Used to Raise the Temperature of the Walls Separate calculations were made each period for red brick and fire brick. The heat loss was found by multiplying the mass of brick in pounds times the average temperature rise of the brick times the specific heat[13] of the brick at the average initial and final temperatures.

The calculation was made for each period.

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* Ratio of molecular weight of water to that of hydrogen.

[11] "Fan Engineering," Buffalo Forge Company. W. H. Carrier.

[12] From model heat capacity curves, *loc. cit.*

[13] The specific heat of fire brick was obtained from a curve drawn from Mellor's formula: $C = 0.192 + 0.000033T$. The sp. ht. of red brick was read from a curve obtained by drawing a line through Trinks' Value (2.00 at 500°F) parallel to the fire-clay brick.

(12) Heat Used to Raise the Temperature of the Crown This loss was calculated the same as above using the weights of fire brick and red brick of the crown as determined from drawings.

(13) Unaccounted for Losses Including Radiation and Convection Losses This item was obtained by difference.

V. Average Data of All Tests

In Tables I to V, inclusive, the percentage heat dissipation for the various kiln tests for each period of the firing is given. Table VI shows the heat dissipation summarized and expressed in percentage for the entire firing for each test of the kiln survey.

NOTE: All tests burned coal except the last six. Of this group Test 31 burned natural gas and the remainder burned oil.

TABLE I

HEAT ACCOUNTS (PER CENT) FIRST PERIOD (START 350°F)

Test	Total heat input	Heat to fire ware	H_2O removed ware	Combustible in ash	Combustible in flue gas	Heat in dry flue gas	Water from hydrogen in fuel	Water in air entering	Water in fuel as fired	Given up to kiln bottom	Stored in kiln walls	Stored in kiln crown	Unaccounted for loss
1	100	17.99	20.07	1.62	21.57	11.02	3.51	0.19		4.94			
2	100	16.00	26.49	2.83	8.20	26.22	4.28	0.17		6.67			
3	100	18.48	38.78	2.85			6.82						
5	100	19.12	8.47	4.81	14.37	20.83	3.79	0.16	0.54	0.16	5.65	4.84	17.26
6	100	23.30	8.54	4.14	5.14	12.68	3.80		0.59		9.48	9.24	23.10
7	100	14.70	7.89	4.30	25.59	30.49	3.89	0.18	0.55	0.92	5.81	5.90	0.22
8	100	20.29	7.24	4.45	11.37	7.34	3.77	0.94	0.52	0.16	7.64	6.07	31.04
9	100	11.73	4.24	3.88	15.58	7.01	3.38	0.08	0.12	1.98	4.32	3.78	43.88
10	100	13.18	14.92	3.62	15.04	14.51	3.53	0.32	0.18	0.88	7.84	6.46	19.51
11	100	21.27	6.52	4.67	9.29	15.76	3.41	0.26	0.15	1.44	0.48	5.80	30.98
12	100	18.27	10.50	2.22	10.41	15.59	3.44	0.26	0.24	4.04	5.49	5.18	24.36
13	100	21.57	18.48	5.56	8.18	17.45	3.44	0.36	0.13	0.69	4.69	5.50	13.94
14	100	21.57	20.38	3.27	12.88	10.74	2.90	0.21	0.15	4.55	3.66	7.02	12.70
15	100	14.91	4.26	0.82	10.99	9.45	3.38	0.18	0.16	10.65	7.32	5.01	32.87
18	100	21.05	14.36	3.38	14.28	15.88	3.49	0.31	0.40	2.18	15.93	6.57	2.16
20	100	22.77	5.41	0.96	15.36	17.09	3.53	0.15	0.24	2.64	12.86	8.70	10.28
24	100	15.80	6.20	1.11	13.83	15.42	3.76		0.17		4.93	5.27	33.52
25	100	23.61	17.24	2.47	8.26	27.85	3.88		0.23		6.88	6.50	3.08
26	100	24.49	12.22	2.82	12.89	14.13	3.53	0.12	0.16		7.03	5.90	16.69
27	100	24.08	7.08	2.24	10.21	20.88	3.90		0.20	0.10	6.26	5.78	19.27
29	100	31.32	6.51		6.55	7.60	6.21	0.02			8.02	7.38	26.38
30	100	42.12	11.14		5.17	7.53	6.03	0.04			5.94	11.20	10.83
31	100	33.49	6.52		5.23	15.42	10.30	0.13		1.18	0.37	8.74	18.61
32	100	37.42	7.98		5.91	9.36	6.06	0.05		0.83	7.99	12.46	11.95
33	100	38.47	9.76		6.90	1.44	2.03			4.38	8.73	9.26	19.04
34	100	44.27	5.44		7.96	1.61	2.78			3.49	8.46	12.01	13.97

TABLE II

HEAT ACCOUNTS (PER CENT) SECOND PERIOD (350 TO 800°F)

Test no.	Total heat input	Heat to fire the ware	Water from ware	Combustible in ashes	Combustible in flue gas	Heat in dry flue gas	Water from hydrogen in fuel	Water in air entering	Water in fuel as fired	Given up to bottom	Heat stored in walls	Heat stored in crown	Unaccounted for loss
1	100	19.48		1.62	4.02	31.48	3.79	0.57		16.35			
2	100	37.77		2.83	2.04	24.45	3.90	0.17		12.18			
3	100	23.29		2.86			3.82						
5	100	38.04		4.81	3.56	18.58	4.03	0.11	0.57	6.15	14.73	5.81	3.61
6	100	35.07	1.96	4.14	0.97	13.43	4.13		0.58	7.78	16.10	6.65	9.19
7	100	31.53	0.79	4.30	4.58	17.33	2.93	0.06	0.59	9.35	10.72	7.76	10.06
8	100	36.98	0.55	4.46	1.91	7.85	3.90	0.05	0.54	4.21	14.89	11.12	13.54
9	100	30.10	0.34	3.88	2.64	19.56	3.66	0.29	0.23	12.83	3.99	6.64	10.46
10	100	32.64		3.62	3.13	14.43	3.76	0.28	0.24	7.65	10.77	13.68	9.80
11	100	32.85	0.32	4.67	2.24	14.74	3.67	0.31	0.19	9.06	13.52	11.31	7.13
12	100	39.58		2.23	1.57	11.06	3.51	0.07	0.21	7.73	14.63	12.52	6.89
13	100	38.12	0.53	5.56	1.04	10.68	3.46	0.21	0.18	5.60	13.87	11.29	0.46
14	100	35.87		3.27	2.23	12.12	3.50	0.18	0.16	7.42	15.93	10.58	8.74
15	100	18.65		0.82	4.61	30.23	3.41	0.52	0.18	22.98	8.62	6.76	3.20
18	100	36.56	0.17	5.70	3.10	15.43	3.67	0.26	0.38	7.65	12.66	13.33	1.14
20	100	43.95	1.67	0.96	3.67	14.40	3.66	0.19	0.29	6.95	14.05	15.95	−5.72
24	100	34.94	1.95	1.11	5.81	21.51	4.14		0.18	6.63	12.43	9.69	1.62
25	100	35.44	1.72	2.47	2.90	28.08	4.50		0.27	8.20	11.92	7.88	−3.43
26	100	38.11	4.01	2.80	3.20	24.58	3.85	0.12	0.17	8.12	15.01	10.32	−10.31
27	100	30.20	1.40	2.24	3.11	24.53	4.50		0.30	10.24	11.60	8.32	3.57
29	100	28.85	0.66		2.51	18.25	7.32	0.08		7.96	11.91	4.73	17.74
30	100	39.85	3.88		1.11	15.19	6.42	0.07		4.24	16.36	6.73	6.21
31	100	35.49	1.89		2.43	14.14	10.88	0.04		5.10	17.59	10.06	2.37
32	100	38.48	1.30		1.86	13.85	6.41	0.04		5.14	17.40	9.17	6.35
33	100	38.72	2.35		2.90	9.92	6.21	0.05		10.82	13.81	8.83	6.38
34	100	44.10	0.97		1.59	6.66	6.07	0.10		8.30	17.01	10.31	4.90

TABLE III

HEAT ACCOUNTS (PER CENT) THIRD PERIOD (800 TO 1400°F)

Test no.	Total heat input	Heat to fire the ware	Water from ware	Combustible in ashes	Combustible in flue gas	Heat in dry flue gas	Water from hydrogen in fuel	Water in air entering	Water in fuel as fired	Heat given up to bottom	Heat stored in walls	Heat stored in crown	Unaccounted for loss
1	100	13.25		1.62	2.70	41.94	4.34	0.32		10.60			
2	100	19.77		2.83	1.15	35.65	4.42	0.40		10.18			
3	100	13.80		2.85	2.92	52.3	5.12	0.22		11.83			
5	100	21.69		4.81	0.97	22.05	4.59	0.07	0.66	10.3	9.77	4.27	20.79
6	100	25.96		4.14	0.67	16.61	4.44	0.07	0.63	13.54	11.75	7.85	14.34
7	100	22.02		4.30	1.44	25.02	4.69	0.10	0.67	11.08	9.18	6.48	15.02
8	100	34.96		4.45	0.76	12.17	4.44	0.05	0.89	10.09	14.90	8.64	8.65
9	100	20.85		3.87	0.86	30.11	4.20	0.56	0.18	12.46	9.52	6.09	11.29
10	100	20.04		3.62	0.60	26.87	4.31	0.54	0.30	12.13	9.90	6.52	15.18
11	100	30.27		4.67	0.64	12.73	3.82	0.22	0.14	12.10	11.61	8.07	15.74
12	100	35.10		2.22	0.02	12.68	3.93	0.21	0.21	12.83	7.70	9.18	15.91
13	100	33.46		5.56	0.31	7.70	3.82	0.09	0.14	10.85	10.78	8.04	19.25
14	100	37.98		3.27	0.07	8.10	3.75	0.15	0.15	12.28	10.42	9.10	14.73
15	100	15.49		0.82	1.59	27.66	4.12	0.57	0.18	19.28	5.54	4.58	20.17
18	100	20.58		3.41	0.58	22.10	4.24	0.40	0.56	17.36	6.74	3.70	20.32
20	100	38.87		0.96	0.32	11.93	3.98	0.08	0.35	12.00	11.25	11.41	8.84

TABLE III (*Continued*)

HEAT ACCOUNTS (PER CENT) THIRD PERIOD (800 TO 1400°F)

Test no.	Total heat input	Heat to fire the ware	Water from ware	Combustible in ashes	Combustible in flue gas	Heat in dry flue gas	Water from hydrogen in fuel	Water in air entering	Water in fuel as fired	Heat given up to bottom	Heat stored in walls	Heat stored in crown	Unaccounted for loss
24	100	31.97		1.11	0.64	21.67	5.11		0.24	12.81	11.43	10.15	4.87
25	100	14.73		2.47	1.65	46.34	5.06		0.28	13.66	5.55	5.29	4.98
26	100	33.23		2.80	0.83	20.92	4.28	0.10	0.30	11.47	13.30	9.02	3.74
27	100	26.61		2.23	0.88	33.48	5.03		0.22	13.34	7.32	6.73	4.15
29	100	16.91			0.71	29.62	8.09	0.08		11.48	8.16	4.14	20.81
30	100	32.20			0.34	15.90	7.42	0.05		9.76	13.44	7.89	13.00
31	100	24.73			0.75	19.96	12.26	0.12		12.44	11.46	5.84	12.45
32	100	24.25			0.81	25.00	7.42	0.08		10.60	10.18	5.24	16.41
33	100	27.12			0.27	5.46	6.76	0.08		17.86	7.66	4.34	30.45
34	100	26.35			0.08	12.78	6.78	0.14		15.73	12.29	4.48	21.36

TABLE IV

HEAT ACCOUNTS (PER CENT) FOURTH PERIOD (1400 TO 1900°F)

Test no.	Total heat input	Heat to fire the ware	Water from ware	Combustible in ashes	Combustible in flue gas	Heat in dry flue gas	Water from hydrogen in fuel	Water from air entering	Water from fuel as fired	Heat to kiln bottom	Heat to kiln walls	Heat to kiln crown	Unaccounted for losses
1	100	16.32		1.62	0.67	34.77	4.99	0.33		12.66			
2	100	18.92		2.83	0.67	32.72	4.90	0.42		17.12			
3	100	16.52		2.85	2.55	60.80	6.10	0.26		19.84			
5	100	24.10		4.81	4.04	18.53	5.05	0.09	0.72	12.89	9.53	4.22	16.02
6	100	23.69		4.14	0.42	19.24	5.15	0.06	0.86	13.89	8.76	5.10	18.69
7	100	22.65		4.30	2.69	25.67	5.22	0.10	0.74	16.27	9.17	3.71	9.48
8	100	17.29		4.45	6.62	17.74	5.02	0.05	0.56	11.08	10.35	3.58	23.26
9	100	16.53		3.88	0.64	36.32	5.01	0.39	0.24	15.91	7.81	4.01	9.26
10	100	15.93		3.62	0.02	30.36	5.09	0.32	0.33	14.09	8.76	6.97	14.27
11	100	27.05		4.41	0.015	18.18	4.15	0.16	0.15	15.41	10.13	6.60	13.74
12	100	23.01		2.23		20.25	4.53	0.35	0.20	18.05	10.79	6.24	14.35
13	100	25.92		5.56	0.12	16.05	4.46	0.21	0.20	16.43	10.14	5.17	15.74
14	100	24.17		3.27		16.96	4.37	0.32	0.21	19.50	8.04	5.43	17.73
15	100	15.56		0.68	0.36	29.27	4.76	0.46	0.22	13.59	6.97	4.47	23.66
18	100	19.17		2.00	0.06	27.68	4.77	0.53	0.34	17.81	7.84	6.50	13.06
20	100	16.62		0.96	0.11	27.64	4.70	0.13	0.34	21.94	6.65	3.38	17.55
24	100	28.59		1.11	0.06	22.06	5.59		0.34	16.96	13.68	7.88	3.74
25	100	24.12		2.34	0.04	28.34	5.80		0.35	13.72	12.27	6.89	6.17
26	100	22.64		2.80	0.29	26.37	4.82	0.10	0.31	15.38	9.61	5.57	12.11
27	100	20.72		4.31		20.12	5.33		0.40	15.90	13.41	6.92	12.88
29	100	21.82			0.02	29.22	8.51	0.12		14.14	11.53	3.50	11.15
30	100	25.92			0.19	28.52	8.40	0.08		13.92	15.93	4.54	2.49
31	100	19.83			0.11	24.60	13.86	0.20		17.76	12.74	2.80	8.11
32	100	28.28			0.20	22.57	8.47	0.10		13.10	14.18	6.06	7.03
33	100	31.94				16.17	7.76	0.14		17.88	17.08	4.29	4.73
34	100	35.09			0.06	14.63	7.76	0.12		15.29	14.92	5.51	6.72

TABLE V

HEAT ACCOUNTS (PER CENT) FIFTH PERIOD (1900° TO FINISH)

Test no.	Total heat input	Heat to fire the ware	Water from ware	Combustible in the ash	Combustible in flue gas	Heat in dry flue gas	H_2O from hydrogen of fuel	H_2O from air entering	H_2O from fuel as fired	Heat to kiln bottom	Heat to kiln walls	Heat to kiln crown	Unaccounted for losses
1	100	8.12		1.62	0.14	30.08	5.36	0.32		16.67			
2	100	6.37		2.83	0.25	29.25	5.30	0.39		14.53			
3	100	11.24		2.85	0.15	39.09	5.96	0.13		26.88			
5	100	10.89		4.81	9.04	23.42	5.73	0.10	0.82	11.31	2.99	1.44	29.45
6	100	5.65		4.14	2.63	28.80	5.98	0.08	0.66	12.05	3.31	1.57	35.13
7	100	5.57		4.30	4.96	30.25	5.86	0.07	0.84	11.98	4.46	3.35	28.26
8	100	5.56		4.45	10.34	25.72	5.95	0.14	1.05	8.08	4.08	1.07	32.66
9	100	8.46		3.86	0.27	38.96	5.42	0.38	0.23	7.92	9.33	2.57	22.60
10	100	10.14		3.62		32.18	5.41	0.30	0.31	14.70	6.85	7.96	18.53
11	100	15.24		2.09		31.32	5.75	0.26	0.22	18.32	11.71	3.33	11.77
12	100	17.68		1.24		27.77	4.37	0.50	0.32	35.59	6.17	2.67	3.69
13	100	21.44		1.40	0.26	20.30	4.11	0.28	0.19	14.72	8.89	4.81	23.07
14	100	15.08		5.23		26.09	4.87	0.46	0.24	20.29	15.16	1.89	10.69
15	100	11.29		0.68		31.60	5.28	0.70	0.27	15.68	8.04	0.11	26.34
18	100	8.20		1.16		32.95	5.28	0.61	0.48	17.34	5.97	2.95	25.06
20	100	11.07		2.03		25.82	5.12	0.18	0.33	19.29	6.75	2.43	26.98
24	100	13.69		1.28		26.90	6.16		0.33	18.14	10.38	5.52	17.59
25	100	12.85		1.81		29.60	6.09		0.42	13.99	9.95	3.74	21.55
26	100	10.32		0.92	0.29	34.68	5.81	0.04	0.30	15.43	8.08	1.51	22.61
27	100	9.23		4.96		29.17	5.87		0.58	18.70	8.55	4.16	18.77
29	100	8.16				34.51	10.11	0.18		15.15	9.70	2.43	19.76
30	100	9.80			0.13	34.36	8.47	0.16		20.59	4.74	1.57	20.18
31	100	10.19				26.34	15.06	0.39		16.51	10.80	3.96	16.76
32	100	8.04				36.80	9.42	0.15		14.35	8.88	3.36	18.99
33	100	9.61				21.78	8.92	0.17		22.29	14.77	3.04	19.41
34	100	11.78				21.05	8.42	0.16		19.98	12.82	3.97	21.82

TABLE VI

HEAT ACCOUNTS FOR ENTIRE TEST (PER CENT)

Test no.	Total heat input	Heat to fire the ware	Water from the ware	Combustible in the ashes	Combustible in the flue gas	Heat in dry flue gas	Water from H_2 in fuel	Water in air entering	Water in fuel as fired	Heat given up to bottom	Heat stored in walls	Heat stored in crown	Unaccounted for losses
1	100	14.97	1.95	1.61	3.93	33.86	4.45	0.35		12.28			
2	100	18.99	2.92	2.82	0.86	28.95	4.65	0.34		13.49			
3	100	16.15	2.31	2.92			5.19						
5	100	21.20	0.94	4.79	5.62	20.97	4.86	0.10	0.69	9.66	8.06	3.76	19.50
6	100	19.46	0.84	4.14	1.48	20.62	5.05	0.05	0.69	11.50	8.47	5.04	22.55
7	100	11.74	0.90	4.30	5.68	26.55	4.90	0.10	0.72	11.37	7.54	4.93	15.65
8	100	17.06	0.67	4.45	7.26	18.46	5.13	0.52	0.82	8.16	8.55	4.55	24.76
9	100	18.99	0.60	3.88	2.84	28.31	4.38	0.37	0.21	12.52	8.19	4.89	14.80
10	100	18.35	1.87	3.62	2.46	25.55	4.52	0.38	0.29	11.11	9.07	7.66	15.08
11	100	25.97	0.83	4.16	1.43	18.17	4.17	0.22	0.16	12.51	10.03	6.94	15.22
12	100	26.35	1.52	2.09	1.65	17.72	4.09	0.29	0.23	16.07	8.89	6.95	14.11
13	100	28.31	2.12	5.07	1.18	13.69	4.02	0.20	0.17	11.78	9.98	6.59	16.85
14	100	28.01	2.08	3.48	1.61	14.38	4.00	0.26	0.19	14.61	10.01	6.81	14.51
15	100	15.05	0.41	0.76	2.24	27.40	4.35	0.52	0.20	27.40	6.94	4.02	21.34
18	100	18.88	1.09	2.77	1.57	24.81	4.49	0.45	0.46	15.49	8.00	5.19	16.75
20	100	20.94	0.42	1.24	1.23	23.03	4.56	0.13	0.32	17.44	8.28	5.58	17.49

TABLE VI (*Continued*)
HEAT ACCOUNTS FOR ENTIRE TEST (PER CENT)

Test No.	Total heat input	Heat to fire the ware	Water from the ware	Combustible in the ashes	Combustible in the flue gas	Heat in dry flue gas	Water from H_2 in fuel	Water in air entering	Water in fuel as fired	Heat given up to bottom	Heat stored in walls	Heat stored in crown	Unaccounted for losses
24	100	24.73	1.03	1.15	2.64	22.34	5.21		0.28	12.92	11.13	7.66	10.88
25	100	19.76	1.30	2.28	1.46	34.52	5.33		0.32	12.18	9.11	5.71	8.46
26	100	23.36	1.28	2.21	1.58	26.79	4.79	0.08	0.28	12.57	10.54	5.73	12.17
27	100	20.06	0.70	3.56	1.39	27.06	5.21		0.39	14.24	9.56	6.10	11.71
29	100	19.24	0.37		0.93	27.64	8.34	0.10		11.78	9.90	3.91	17.78
30	100	26.20	0.98		0.54	23.95	7.81	0.08		12.30	12.30	5.23	10.13
31	100	22.07	0.51		0.79	21.87	13.06	0.18		13.73	11.93	5.01	10.83
32	100	23.54	0.52		0.82	25.26	7.98	0.10		11.05	11.51	5.76	13.44
33	100	27.03	0.82		0.81	12.12	7.15	0.11		17.17	12.60	4.86	17.29
34	100	29.03	0.35		0.58	13.58	7.06	0.12		14.99	13.46	5.65	15.15

VI. Brief Discussion of Data

It can be seen that the heat to the ware, heat in the dry flue gases, the heat stored in the kiln structure, and the unaccounted for loss which includes radiation and convection are the large items of the accounts.

Kiln efficiencies were found ranging from 11.74 to 29.03%. The only recent mention of sewerpipe kiln efficiency was that of Robert Linton[14] which was stated to be only 8%. It is evident that the recent kiln studies have developed much greater efficiencies.

Kiln efficiencies for individual periods range higher for the second period in most cases with some of the kilns reaching to about 40% efficiency.

In general as the kiln reaches higher temperatures the kiln efficiency decreases due to increasing stack and kiln structure losses.

Discussion of the variation in percentage of the different items or the different tests would involve a rather comprehensive analysis with relation to the variation in conditions of the respective tests and would occupy prohibitive space.

It is expected that later papers will deal with the significant features of such analysis.

[14] "Notes on Firing in Downdraft Periodic Kilns," *Jour. Amer. Ceram. Soc.*, **10**, 493–500 (1927).

CLAY SEWERPIPE MANUFACTURE

VII. Low Temperature Oxidation[1]

By R. E. Arnold and George H. Duncombe, Jr.[2]

ABSTRACT

Data of plant and laboratory experiments on rate of oxidation of carbon found in sewerpipe clays are presented. The effect of some metallic oxides as catalysts in the low temperature combustion of coal is investigated. The difference in rate and completeness of the combustion or volatilization of the various forms of carbon shown in the laboratory studies suggests one explanation of why the clays of the plant experiments oxidize with difficulty at higher temperatures, viz., that the material which forms the black core is of the type of carbon compound which burns readily at low temperatures, and that at higher temperatures it is "cracked" or changes into one of the forms of carbon which burns slowly.

I. Introduction

This is the second paper of a series based on the results of recent investigation of kiln design and operation.

The subject matter of this paper consists of data of plant experiments and observations of oxidation phenomena supplemented with abstracts of laboratory investigation, the purpose of which was to develop satisfactory explanation of the phenomena observed in plant operation.

II. Plant Experiment

The plants from which data were obtained make ware from mixtures of shale and fire clay. In one case the shale occurs in the same pit below the fire clay and in the other case the shale comes from a separate mine. In both cases the body has considerable iron and sulphur and gives off large quantities of white "sulphur smoke" over a considerable temperature range above 1400°F.

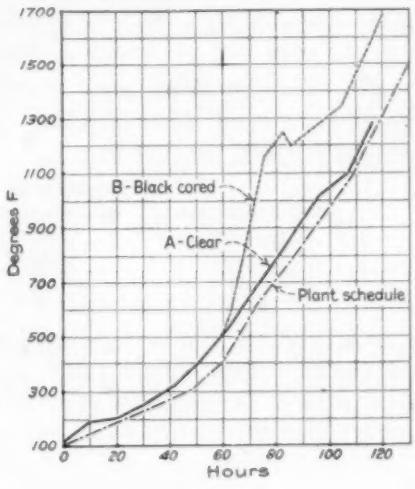

Fig. 1.

The significant data of experiments in which the results of changes in the rates of heating were observed are abstracted from the reports of the experiments and presented in Figs. 1, 2, and 3.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Heavy Clay Products Division.)

[2] Industrial Fellows, Clay Products Association Industrial Fellowship, Mellon Institute, Pittsburgh, Pa.

The data of firing experiments show that "black core" which is difficult to burn out at temperatures[3] above 1100°F, when relatively fast temperature increments are used up to that point, is easily burned out in the range between 900 and 1100°F when slower rates are used between 600 and 1000°F. They also show that with these same clays if the rate is reduced still further in the range between 600 and 900°F the "black core" will not be visible as such at any stage of the firing.

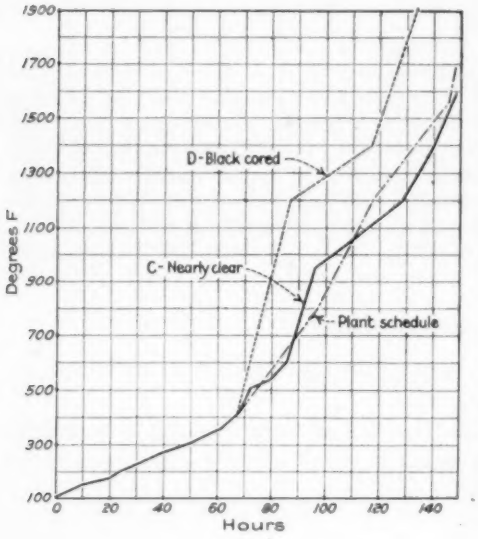

FIG. 2.

To the extent that black coring was encountered in kiln investigations it was best eliminated by slow heating in the range between 400 and 1000°F.

A comparison of temperature increments in Test C (black cored) and Test D (clear) indicates that the active range is between 600 and 950°F.

TEMPERATURE INCREMENT

Temperature range	Test C	Test D
400–600	10.0° per hour	18.2° per hour
600–950	29.2°	9.0°
950–1200	8.1°	9.6°
1200–1600	19.1°	28.6°

Since at both plants heavy white "sulphur fumes" were given off in the temperature range above 1400°F and practically colorless gases were given off in the temperature range at which the black core material was readily removed, it was reasoned that carbon rather than sulphur was the black coring agent.

III. Abstract of Laboratory Investigation

The observed results of plant experiments gave rise to laboratory investigation of the temperature and rates at which various forms of carbon would burn and also the influence of various metallic oxides as impurities on these temperatures and rates. Laboratory investigations are abstracted as follows:

[3] The temperatures given in plant experiments are kiln control temperatures read from thermocouples placed in the crown.

(1) Identification of the Substance of the Black Core in Sewer Pipe

Samples of black cored and clear body of the same ware were ground and digested while hot with equal parts of hydrofluoric and dilute sulphuric acid. After seven hours the clear body had almost entirely dissolved while there was considerable black residue from the black-cored body.

Tests showed that a portion of the black-cored material was magnetic and it was presumed that due to the presence of excess carbon some of the iron oxide had been reduced to magnetic oxide which is very difficult to oxidize. Most of the residue was not magnetic and was presumed to be carbon.

(2) Oxidation of Carbon at Low Temperature

Samples of powdered bituminous coal (Powellton heated in an open crucible at 700 to 800°F (±30°F) for 3 hours lost 95.04% in weight.

$$\text{Approximate analyses of coal} = \begin{cases} \text{vol.} & 32.9\% \\ \text{ash} & 3.7\% \\ \text{sulphur} & 0.7\% \end{cases}$$

(3) Oxidation of Carbon at Low Temperature

Samples of graphite heated for 1 hour at 800°F (±30°F) lost 0.12%.

(4) Oxidation of Carbon at Low Temperature

Analyses of gases given off. A sample of coal (Powellton) at 800°F was treated with air in a combustion train for 3 hours and the gas analyzed.

The coal lost 80.9% weight.

	Analyses of Gas	
	After 1 hr.	After 3 hrs.
CO_2	1.81	1.74
Illuminates	0.22	0.10
O_2	16.03	18.80
H_2	4.40	2.84
CO	3.47	1.99
N_2	74.07	74.53
CH_4	nil	nil
C_2H_6	nil	nil

(5) Low Temperature Combustion of Some Organic Fuels and Other Hydrocarbons

The materials tested were paper, wood, wood charcoal, sugar, asphalt, coke, high volatile and low volatile bituminous coal, and anthracite coal.

The combustions were carried out in an electric muffle and the temperature registered by means of a chromel-alumel thermocouple and a millivoltmeter. The temperatures used were 800, 600, and 500°F; the percentage loss in weight of the samples in unit time increased with the temperature.

All temperatures were below red heat but incandescence was noticed

with charcoal and low volatile bituminous coal at 410°F. Fumes were noticeable with asphalt (California "hard") and with high volatile bituminous coal at this same temperature.

	Percentage Loss in Weight							
Material	800°F 1 hr.	800°F 2 hrs.	800°F 8½ hrs.	600°F 1 hr.	600°F 3 hrs.	500°F 1 hr.	500°F 2 hrs.	500°F 18 hrs.
Paper	98.50	99.85		93.7	97.90	96.55	96.55	97.40
Wood	99.90	99.85						
Wood charcoal	97.96	97.96		48.40	84.50	34.28	34.85	37.50
Sugar	100.00	100.00						
Asphalt	99.20	99.63						
Coke	19.80		24.60	0.70	2.40	0.30	0.30	1.20
Anthracite	37.20		70.18					
Low volume bituminous	77.50		87.15					
High volume bituminous	88.65		95.75	2.20	31.90	0.73	1.08	8.62
Charcoal	95.53		97.43					

Supplementary tests, two in number, to determine by means of the rate of heating whether or not the incandescence noted in the charcoal was merely on the surface or also in the interior of the sample, were less conclusive. For these tests two thermocouples were used, one to record the muffle temperature and the other was buried in the sample so as to record the temperature of the sample itself. As expected, the sample was slower in heating up initially, but reached a higher temperature than the muffle. It was reasoned that during the heating of the sample the rate of heating would greatly increase when the body reached such a temperature as to become incandescent. Such an increase was noted, but it was not as great as expected in either of the two tests.

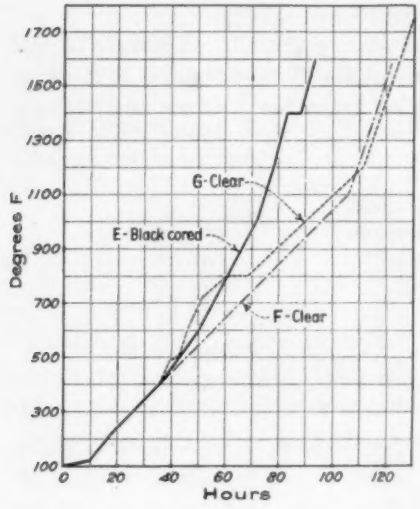

FIG. 3.

All of the materials were almost completely burned off by heating for 2½ hours at 800°F with the exception of coke which lost 24.6% in weight, anthracite coal which lost 70.18% in weight, and low volatile bituminous coal which lost 87.15% in weight. All were ashed almost completely. The results at the lower temperatures (500 and 600°F) were in corresponding order.

High volatile organic impurities in clays should then be completely driven off by heating to a comparatively low temperature.

Even at the low temperatures of these tests a few of the materials of low volatile content but of comparatively low combustion temperature, namely, charcoal and low volatile bituminous coal, became incandescent.

(6) Effect of Some Metallic Oxides as Catalysts in Low Temperature Combustion of Coal

In this experiment one-gram samples of high volatile bituminous coal of 2.51% ash were weighed out into weighed, ignited porcelain crucibles. To these samples was added such an amount of solution of soluble salts of the metals as would yield upon heating about one-tenth of a gram of the metallic oxide. For this test chlorides and acetates were chiefly used. The wetted samples were allowed to stand for a short time and then gently heated so as to drive off the acid without spattering and to give an intimate mixture of the catalyst and the coal.

The crucibles, together with a blank containing coal only, were then placed in an electric muffle at 700°F and weighed hourly for five hours. They were then kept at this temperature over night, a total elapsed time of twenty-one hours, and then ignited to constant weight over a blast lamp.

On the assumption that there was no loss of catalyst in the process of heating and ignition, and that the coal ash after ignition would be the same as the value of the sample analyzed the results were calculated as per cent loss in terms of the original weight of coal as shown below:

TABLE I

PERCENTAGE WEIGHT LOSS

700°F

Catalyst	1 hour	2 hours	3 hours	4 hours	5 hours	21 hours	After ignition
Blank I	48.59	72.59	82.74	87.14	88.94	97.29	97.49
Fe_2O_3	81.72	87.77	91.32	92.87	93.67	97.12	97.47
Al_2O_3	61.79	82.29	88.89	91.19	92.29	96.59	97.49
ZnO	27.12	49.04	63.72	70.47	73.71	97.19	97.49
Na_2O	48.31	69.08	80.16	83.91	85.76	94.59	97.47
Blank II	45.20	72.95	85.05	89.40	91.00	97.60	97.63
CeO_2	34.79	61.14	76.64	82.07	84.64	96.68	97.49
CoO	43.43	76.95	86.71	90.11	91.51	96.30	97.48
CuO	79.74	91.99	94.09	94.84	95.34	97.24	97.49
NiO	20.14	62.59	73.49	78.39	86.44	96.99	97.49
Blank III	49.83	61.91	66.78	70.62	78.10		97.49
CrO	67.72	78.12	80.66	83.82	86.80		97.49
MnO_2	62.39	71.05	75.11	77.89	81.21		97.49
WO_3	47.43	58.78	62.23	64.03	67.21		97.49
V_2O_5	46.33	53.33	57.27	59.21	62.38		97.49
MoO_3	55.71	62.98	66.55	68.71	72.08		97.49

Because of the slower rate of weight loss in the third test (those below Blank III and associated with it), a second table was drawn up to present the results in terms of the difference between the values for the metals at each designated time and the value for the blank with which it was run.

TABLE II

ACTUAL DIFFERENCES BETWEEN WEIGHT LOSS VALUES

700°F

For the Metal Oxides and the Blanks

Catalyst	1 hour	2 hours	3 hours	4 hours	5 hours	21 hours
Fe_2O_3	+33.13	+15.18	+ 8.58	+ 5.73	+ 4.73	−0.17
Al_2O_3	+13.20	+ 9.70	+ 6.15	+ 4.05	+ 3.35	−0.70
ZnO	−21.47	−23.55	−19.02	−16.67	−15.23	−0.10
Na_2O	− 0.28	− 3.51	− 2.58	− 3.23	− 3.18	−2.70
CeO_2	−10.41	−11.81	− 8.41	− 7.33	− 6.36	−0.92
CoO	− 1.77	+ 4.00	+ 1.66	+ 0.71	+ 0.51	−1.30
CuO	+34.54	+19.04	+ 9.04	+ 5.44	+ 4.34	−0.36
NiO	−25.06	−10.36	−11.56	−11.01	−10.56	−0.61
CrO_3	+17.89	+16.21	+13.88	+13.20	+ 8.70	
MnO_2	+12.56	+ 9.14	+ 8.33	+ 7.27	+ 3.11	
MoO_3	+ 5.88	+ 1.07	− 0.23	− 1.91	− 6.02	
WO_3	− 2.40	− 3.13	− 4.55	− 6.59	−10.89	
V_2O_5	− 3.50	− 8.58	− 9.51	−11.41	−15.72	

\+ Signifies metal shows the greater value (promoter)
− Signifies metal shows the lesser value (retarder)

At 700°F the results were roughly as follows:

Oxides promoting combustion: iron, aluminum, copper, chromium, manganese, molybdenum.

Oxides retarding combustion: zinc, cerium, nickel.

Oxides exhibiting little effect: sodium, cobalt, tungsten, vanadium.

At about 800°F one series of tests gave practically complete combustion in one hour with all metals in that particular test.

IV. Conclusions

Some sewerpipe mixtures can be oxidized most efficiently by burning out the black core material in the temperature range between 500 and 1000°F.

Apparently the black core material is some form of carbon.

Many forms of carbon burn completely and rapidly at a temperature of 800°F.

The difference in rate and completeness of the combustion or volatilization of the various forms of carbon shown in the laboratory studies suggests one explanation of why the clays of the plant experiments oxidize with difficulty at higher temperature; viz., that the material which forms the black core is of the type of carbon compound which burns readily at low temperature, and that at higher temperatures it is "cracked" or changed into one of the forms of carbon which burns slowly.

The oxides which promote low temperature combustion of coal rather than those which retard the reaction are among those usually present in sewerpipe clays which suggests that low temperature oxidation of clays having other forms of carbon may be promoted also and that the theory of low temperature oxidation of clays should be generally applicable.

CLAY SEWERPIPE MANUFACTURE[1]

VIII. Measurement of Draft Distribution

By C. E. Parmelee[2]

ABSTRACT

A method used in measuring the draft distribution in sewerpipe kilns is described and the significance of draft measurement in kiln studies is discussed. In the progress of the kiln studies several types of kiln bottoms were investigated. These ranged from one extreme to the other in the type and arrangement of flues and openings. The kilns studied had ring, spoke, spider, or "T" flue systems, together with solid or open-feature walls, and in some cases a double-feature wall system. Draft-distribution studies of these types of construction brought out widely varying conditions. The possibilities offered in correcting faulty conditions by the use of this method of measuring the distribution are discussed.

Introduction

The kiln studies conducted for the Clay Products Association by the Mellon Institute of Industrial Research brought out a number of individual problems which were necessary to consider in developing the main purpose of the investigation. Among these was the question of measurement of draft distribution.

It is the purpose of this discussion to outline the methods used in measuring the draft distribution in the sewerpipe kilns and their significance in measuring the effect of changes in area and proportions of the flue openings.

The subject will be considered in three parts as follows: (1) significance of draft measurement in kiln studies; (2) factors in draft distribution; and (3) method of measuring the distribution.

(1) Significance of Draft Measurement in Kiln Studies

The effect of poor heat distribution across the kiln bottom with its accompanying second class ware when the kiln is unloaded is a common problem. This is true particularly in firing practice where it is necessary to fire all ware to certain standards of vitrification in order that the strength requirements may be met and also obtain a good glaze on all of the pipe. Investigation has shown that the heat distribution in round downdraft kilns used for sewer pipe is a function of the draft distribution and that good or bad results with regard to uniformity of strength and glaze is directly traceable to the draft distribution.

Cases were on record from the data obtained in the kiln studies where 80 to 100% of the combustion gases were passing down through the outer portions of the kiln while in other kilns the greater portion of the

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Heavy Clay Products Division.)

[2] Industrial Fellow Clay Products Association Industrial Fellowship, Mellon Institute, Pittsburgh, Pa.

gas flow was down the center portion of the kiln. In the first case the center was heated strictly by radiation and the uniformity of product was satisfactory if there was enough soaking at the finish. For this reason many will be inclined to argue that such a distribution gives satisfactory results. No doubt this would be satisfactory from the quality standpoint in clays that will stand severe firing treatment, but hardly efficient kiln operation from the fuel economy side. In the case of the greater flow of gas to the center of the kiln it was common to find underfiring of pipe set between bag walls ("the pockets" in plant parlance). With such a condition nothing except excessive soaking and higher temperatures than the maturing limits demanded for most of the kiln would give first grade pipe from these locations. And with a delicate clay, easily overfired, as is often the case in all except the fireclay districts, such methods are not permissible.

Tables I and II show the type of results obtained based on measurements made on pieces fired in the test kilns. Table I is based on measurements of glaze thickness. Case "A" is an example of all gas flow on the outer portions of the kiln. Case "B" is the opposite condition. Case "C" is an example of the type of results obtained after draft distribution measurements had been run and adjustments made to correct the conditions. Table II is an example of the effect on the strength of the pipe. The three cases cited are as outlined for the distribution of glaze thickness.

TABLE I

GLAZE THICKNESS

Location	Case "A"	Case "B"	Case "C"
Kiln average	0.0024 in.	0.0023	0.0034
Bottom average	0.0022	0.0014	0.0026
Bottom outside	0.0024	0.0008	0.0026
Bottom inside	0.0019	0.0027	0.0028

TABLE II

UNIT STRENGTH

Location	Case "A," lbs./ft.	Case "B," lbs./ft.	Case "C," lbs./ft.
Kiln average	1980	1430	1243
Bottom average	1870	1330	1195
Bottom inside	1890	1318	1190
Bottom outside	1830	1365	1205

One more point should be called to the attention of the plant operators in connection with draft distribution. This arose in regard to the benefits obtained by good distribution in aiding the kiln cooling. When cooling air was drawn through the kiln setting uniformly the safest and fastest practical cooling was obtained. Cases were on record of all the air for cooling being drawn through one limited portion of the kiln. The volume and chilling effect were great enough to cause dunting or air checking to a very serious degree. This was overcome by altering the draft distribution on the basis of measurements made as outlined in this discussion.

(2) Factors in Draft Distribution

There are two general ways in which the draft distribution in a kiln is altered. These are (1) by the character of the setting, and (2) by the openings through the kiln floor. This is assuming that the flue system is such that a good distribution of draft pull is possible on all parts of the kiln floor and not concentrated on one limited area.

It is common practice for the plant operators to change flue sizes, floor openings, and types of setting to obtain more uniform heat treatment of the ware throughout the kiln.

In the case of such a product as brick it is possible to vary the resistance to gas flow by altering the kiln setting. Either by setting higher or by giving a more open setting in various parts of the kiln it is possible to change the draft distribution throughout the kiln and such methods are often used to improve the uniformity of the firing. In the case of sewer pipe, however, this is not possible. A kiln loaded with this type of ware represents a series of vertical flues leading from a gas chamber (the space between the top of the pipe and the kiln crown), to the flue system. The resistance to gas flow is practically uniform across the kiln floor with the exceptions of the parts of the kiln where only small size pipe are set. And, therefore, it is necessary to obtain uniformity of firing by adjustment of the draft distribution across the kiln floor.

This can best be done by manipulating the paving-course openings both as to size and distribution. By paving-course openings is meant the openings between the subfloor structure and the distributing or secondary flues. In sewerpipe kilns the typical structure is to have a floor block of about four to six inches in thickness setting on a series of feather walls 12 to 18 inches high. These in turn rest on a foundation known as the paving course. It is through this foundation course that the openings to the flue system are made.

In the progress of the kiln studies several types of kiln bottoms were investigated. These ranged from one extreme to the other in the type and arrangement of both flues and openings. The kilns observed had ring, spoke, spider or "T" flue systems, together with solid or open-feather walls, and in some cases a double-feather wall system. Draft-distribution studies of these types of construction brought out widely varying conditions which have been mentioned in this discussion.

(3) Method of Measuring the Draft Distribution

At best any method of measuring the draft distribution in a round down-draft kiln may be considered relative as the gas-flow conditions of a loaded kiln at high temperatures could not be duplicated for measurement. The general effect, however, of the gas distribution across the kiln floor could

be approximated and after sufficient test data were at hand from the kiln studies it became apparent that the method in use gave a satisfactory measure of the effects obtained in altering the draft distribution.

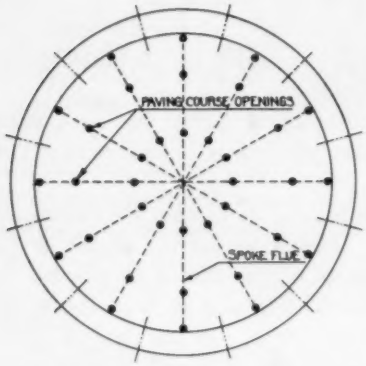

FIG. 1.—Showing approximate location of paving-course openings for spoke flue construction.

For the purpose of this discussion the spoke-flue type of bottom as shown in Fig. 1 as an example is used. The points shown indicate the general location of the openings through the paving course to the spoke flues. The wellhole at the center of the kiln-flue system and the main flue to the stack are not indicated. From this it may be seen that each spoke draws on a segment of the kiln floor and the gas handled in the particular flue represents the amount which can be considered as effective on this particular area of the floor.

To make the draft distribution measurement the procedure was as follows: The induced draft fan was connected to the back-draft opening of the main flue in the same manner that it would be when used for the water-smoking of the kiln, all openings of the kiln with the exception of the fire boxes were closed off, and the bag-wall throats were restricted to some extent to give the effect of the fuel-bed resistance in the fire box under operating conditions. Enough floor blocks were removed to give access to the flue openings. Then the air velocities through the various paving-course openings were measured by the use of an anemometer. The cubic feet per minute handled could then be approximated by determining the area of the opening and taking the product of area times velocity as the volume of air passing this point.

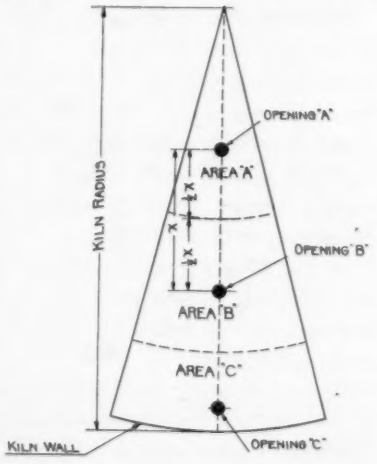

FIG. 2.—Diagram showing segment of kiln floor to illustrate areas effected by different paving-course openings.

After volumes had been determined on all of the openings it was possible to calculate the distribution across the whole floor. As referred to earlier in this discussion the kiln floor was divided into segments to indicate the

distribution in particular areas. Each segment was subdivided as shown in Fig. 2. This illustration represents one segment with the areas on which the effective pull of each floor opening was considered as applied.

When the draft distribution had been determined for the existing conditions it was possible to study the probable effect of altering this factor if the kiln results indicated it should be changed. The usual method adopted after a number of tests had been run on various kilns was to determine the gross area that appeared advantageous from past experience and then figure the sizes of the individual openings. This may appear to have been strictly a "cut and try" procedure, and often would be when experimenting with any one particular kiln, but after certain ratios had been set up and the percentage of draft desirable on any particular floor area as indicated by Sections A, B, or C in Fig. 2 was known it became a matter of simple arithmetic to decide on the altered sizes of the openings. After changing these sizes the draft measurement was repeated to check the results of the alteration and if the calculation indicated that the desired distribution had been obtained the floor blocks were replaced and the kiln was ready for another test firing. If the second draft test was not satisfactory the alterations could be repeated and this done until the test crew felt satisfied with the conditions.

Conclusion

These examples illustrate the true significance of draft distribution and the possibilities offered in correcting faulty conditions by the use of this method of measuring the distribution.

The necessary measurements are comparatively simple and well within the ability of plant operators to make without the use of expensive or delicate equipment.

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Abrasives

Economy of grinding in quantity production of crankshafts. FRED B. JACOBS. *Abrasive Ind.*, **10** [4], 17–21 (1929).—Crankshaft production depends on grinding, not only to produce the demanded accuracy, but to reduce manufacturing time to the extent of permitting the producer to make a profit in the face of keen competition. A few interesting grinding operations performed daily in the manufacture of crankshafts at the plant of the Ohio Crankshaft Co., Cleveland, are described and illustrated. E.P.R.

Abrasive exhibits at American Ceramic Exposition. ANON. *Abrasive Ind.*, **10** [4], 21 (1929); see also *Ceram. Abs.*, **8** [5], 375 (1929). E.P.R.

Metal removing capacity determines grinding machine efficiency. R. E. W. HARRISON. *Abrasive Ind.*, **10** [4], 22–23 (1929).—The basis of all production grinding estimates necessarily must be obtained from the capacity of the grinding machine to remove metal at a predetermined maximum rate. Experience has shown that with modern precision grinding machinery, the maximum metal removal capacity is directly proportionate to the H.P. and, assuming that average conditions of operations obtain, the following table can be applied.

H.P.	5	10	15	20	25	30	35	40
Metal removal capacity (cu. in./min.)	0.5	1	1.5	2	2.5	3	3.5	4

When brought to the grinding machine, work usually runs out of true, and it takes one to five minutes before true cylindricity and parallelism are established, and the wheel can be put to work in such a way that the maximum rate of metal removal can be obtained. This is clearly shown by means of the load cycle diagram. The type of finish demanded influences the total time of operation. E.P.R.

Grinding tungsten-carbide tools. A. H. PREV. *Abrasive Ind.*, **10** [4], 24 (1929).—Dressing of cutting tools of carboloy, Strauss metal, dimondite, widia, and other tung-

sten-carbide materials can be performed only by grinding. Off-hand grinding problems confronting the user of tungsten-carbide tools are discussed. The chief characteristic of tungsten carbide is its extreme hardness. Various Brinell figures show hardness from 1800 to 2400 compared to a maximum of about 800 for hardened high-speed steel when determined in the same manner (Rockwell no load converted to Brinell figures). The new material will scratch sapphire and its hardness lies between that of aloxite (fused alumina) and Carborundum (silicon carbide). Tungsten-carbide material for tools is supplied to the trade at the present time in two forms: (1) a finished tool ready for use, and (2) a roughly shaped piece to be mounted and ground to its final form by the customer. For these operations the gradings of Carborundum products recommended are (1) rough grinding: 60 grit, N to U grades, W bond wheel; (2) finish grinding: 100 to 120 grit, S to V grade, W bond wheel; (3) stoning: any fine grit, medium grade, Carborundum stone, *e.g.*, 4 x 1 x $^1/_2$ 2F—G6. A rigid machine is essential, otherwise wheel wear will be excessive. Wheel speeds should be low rather than high. From 4000 to 5000 surface ft. per min. is about the correct range. The pressure of the tool against the grinding wheel should be light, otherwise excessive wheel wear will result with no faster cutting action. The user must expect a higher wheel wear than when grinding high-speed steel. In the efficient use of the tools made from these raw metals, the clearance and tool angles differ from those standard for high-speed steel and the manufacturer's specifications should be followed closely. If water is used, the supply should be plentiful as a little is worse than none. The heat conductivity of this material is low and there is danger of localized heating and checking. The use of this new tool material is in the experimental stage, consequently the grinding problems are not completely solved. E.P.R.

Use of soft wheel, fine grain, and light pressure. ANON. *Abrasive Ind.*, **10** [4], 24–25 (1929).—Carboloy is a new cutting tool material distributed by Carboloy Co., Inc., New York. It is extremely hard and can be used for machining materials on which ordinary high-speed steels would hardly make an impression. *E.g.*, it will cut grooves or screw threads in a glass bar; it will machine hard porcelain; it will machine on a shaper a block of quenched high-speed steel. This material is more difficult to grind than ordinary high-speed steel, but it is not necessary to grind it frequently. The 60-I wheel cuts rapidly when the hardness of the material is taken into consideration, and with the light pressure recommended the wheel wear should not be excessive. Grinding should be dry, and only light pressure used. In order to avoid grooving the wheel the tool should be kept moving during the grinding operations. Coarser wheels are not desirable because of the rough finish they impart; nor should they be required inasmuch as only small amounts of material are removed. If the edge left by the 60-I wheel is not smooth enough, a 90-H wheel can be used for final finishing. E.P.R.

Double wheel grinders solve boiler section production problem. ANON. *Abrasive Ind.*, **10** [4], 26–27 (1929).—Interesting grinding operations are performed at the Bond plant of the American Radiator Co., Buffalo, where two surfaces on one casting are ground at one setting on specially designed machines. E.P.R.

Abrasive operations in radio manufacture. K. H. LANSING. *Abrasive Ind.*, **10** [4], 28–29 (1929).—The all-in-one type of radio set is equipped with an instrument-container of steel, the welded seams of which must be ground and finish-polished. The cabinet also with steel shell means a further increase in the grinding and polishing treatment. E.P.R.

Precision grinding on milling machine parts. L. SICHEL. *Abrasive Ind.*, **10** [4], 30–31 (1929).—An important part of the process of building a milling machine is the scraping of plane surfaces to secure accurate alignment of the various components. It is entirely possible to grind every flat bearing to a fine finish, close limits, and perfect

alignment, and there are milling machine manufacturers who have ground flat bearings for the last 8 or 10 years. E.P.R.

Nonferrous precision grinding. ANON. *Abrasive Ind.*, **10** [4], 32–33 (1929).—Probably the bulk of precision grinding in this field has been on pistons made of aluminum and aluminum alloys such as lynite, bohnite, duralinum, and others. Aluminum, being a soft but very tough metal, is most essential to get a wheel and work speed that will cut instead of tear the metal. The selection of a proper grain and grade of wheel is of equal importance. To finish pistons a wheel about 2 in. wide usually is used with a straight in-feed at one end and removing from 0.00025 to 0.0005 in. per pass. A good finish depends upon proper wheel speeds, plenty of good clean grinding compound, and timely dressing of wheels. It is very important that the lubricant be strained to take out particles which cause deep scratches in the work. A very good cutting compound for this work is a mixture of kerosene and lard oil. From Norton Co.'s experience, very good results have been obtained with grain 30 to 46, grade J to M crystolon vitrified wheels, running at speeds varying from 5500 to 6000 surface ft. per min., and work speed of 150 to 300 revolutions per min. A medium high wheel speed and high work speed are necessary due to the soft nature of the alloy; if too slow speeds be used, small particles are pulled out and roughness results. Internal grinding is confined almost entirely to the grinding of bushings. Where possibly a lubricant should be used, the same compound used in piston grinding should be found very satisfactory. A grain 24, grade J, crystolon vitrified wheel will give very good results. Surface grinding takes in small castings and parts not covered by previous types of grinding. It can be done on a plane surface grinder or one of the vertical-spindle type. There are several factors influencing the wheel action, but in general the same grain and grade of wheels used on internal grinding will prove satisfactory, except on the vertical spindle type where a 3824 grade I alundum silicate wheel is good for ordinary work. E.P.R.

Coated abrasives standardized. ANON. *Abrasive Ind.*, **10** [4], 34 (1929); for abstract see *Ceram. Abs.*, **8** [1], 3 (1929). E.P.R.

Abrasive exports gain. ANON. *Abrasive Ind.*, **10** [4], 39 (1929).—A substantial gain in the value of abrasive materials exported during 1928 compared with the figures for 1927 is shown in a report recently made public by the U. S. Dept. of Commerce. E.P.R.

Occupy new quarters. ANON. *Abrasive Ind.*, **10** [4], 39 (1929).—The Vincent Steel Process Co., manufacturer of grinding-wheel dressers and cutters, has just purchased a steel and brick building in Detroit. E.P.R.

Oiling centers. ANON. *Abrasive Ind.*, **10** [4], 39 (1929).—White or red lead mixed with lubricating oil is an excellent medium for lubricating the centers when grinding large work such as heavy rolls, etc. Heavy parts put considerable weight on the centers and if they are not lubricated properly, they will wear abnormally. E.P.R.

Grinding wheel data. ANON. *Abrasive Ind.*, **10** [4], 42 (1929).—The New York Belting & Packing Co., New York, has issued a catalog on rubber-bonded grinding wheels. The advantages of the rubber bonds and the type of abrasives used for various grinding operations are mentioned. There also is included a table giving the classes of work that may be ground with rubber-bonded wheels together with data on the use of these wheels for grinding steel and steel alloys, iron, brass, bronze, and nickel. The question of speed is of prime importance in removing stock when using rubber-bonded wheels and they should be operated at least 7500 surface ft. per min. to work satisfactorily, for in no case should the speeds be 10,000 surface ft. per min. The use of iron centers is explained while special-shaped wheels are illustrated and described. Tables give dimensions of iron centers for grinding wheels, minimum sizes of machine spindles, and surface speeds of grinding wheels. E.P.R.

New abrasives warehouse. ANON. *Abrasive Ind.*, **10** [4], 42 (1929).—The Precision Grinding Wheel Co., Inc., Philadelphia, has completed plans for an office and warehouse in Detroit, where a new building is under construction. E.P.R.

Cracking of diamonds. ANON. *Abrasive Ind.*, **10** [4], 43 (1929).—This trouble as a rule develops mainly from one or two causes: the quality of the stone and the manner in which it is used. (1) If the stone is of poor quality, or if it is too small for the wheel on which it is being used, it will invariably chatter and cause cracking; (2) a crack will usually develop if the wheel is not flooded when the truing operation is started. *E.g.*, if the operator starts to dress his wheel dry and then flushes it with cold water which strikes the hot diamond, it will always cause what is termed heat-and-water cracks. These are not necessarily more than "skin deep," but if this practice is continued, it will injure the stone permanently. E.P.R.

To grind aluminum utensils. ANON. *Abrasive Ind.*, **10** [4], 43 (1929).—In some instances aluminum hollow-ware is finished on a so-called hollow-ware grinder. In finishing skillets, they are located in a chuck and rotated at an approximate speed of 60 r.p.m. while the grinding is accomplished with a special shaped wheel called a skillet wheel, run at an approximate peripheral travel of 5000 ft. per min. The abrasive used is silicon carbide, 30 to 36 grit, in a medium-hard grade. E.P.R.

Define burnishing. H. LEROY BEAVER. *Abrasive Ind.*, **10** [4], 43 (1929).—Barrel burnishing is a process for polishing metal products either plain or variously plated to produce either a smooth surface prior to plating or a brilliant finish after plating. The process consists of subjecting the article to be burnished to rotation within a burnishing medium and producing this rotation while the article is suspended in the burnishing medium. E.P.R.

Grinding wheel chuck improved. ANON. *Abrasive Ind.*, **10** [4], 45 (1929).—Notable among abrasive improvements during 1928 was the Sterling Grinding Wheel Co.'s chuck for segmental wheels. Segments are mounted directly on the chuck which makes possible ready changing. The chuck is light, but durable. E.P.R.

High speed grinder. ANON. *Abrasive Ind.*, **10** [4], 45–46 (1929).—Kling Bros. Engineering Works, Chicago, announce a new line of small size grinders known as the Type B high speed grinders. These units are available in either the bench or floor type. E.P.R.

Exhauster equipment. ANON. *Abrasive Ind.*, **10** [4], 46 (1929).—The Hisey-Wolf Machine Co., Cincinnati, recently developed a dust exhausting equipment consisting of a ball-bearing motor vertically mounted with the fan on a bracket at the rear of the machine base while flexible piping leads to the wheel hoods on either side. One automatic starter controls both the power and the exhauster motors. E.P.R.

Heavy duty grinder. ANON. *Abrasive Ind.*, **10** [4], 47 (1929).—The grinding wheel is mounted on a substantial spindle which runs in ball bearings. The bearings are dust proof and mounted one on each of the side members, which units are bolted securely together. Between the side members is a steel trough to supply water for the wheel. Suitable provision for drainage is made. The machine is entirely self-contained and is fitted with a tight and loose pulley and a belt shifter. E.P.R.

High speed grinders. ANON. *Abrasive Ind.*, **10** [4], 47 (1929).—U. S. Electric Tool Co., Cincinnati, announces a new 6-inch grinder which embodies ball bearings, heavy nickel steel spindle, a $^1/_4$ H.P. motor of 3450 r.p.m. at load speed, a fine and coarse wheel 6 x $^1/_2$ in., and adjustable tool rests. The grinder is furnished regularly for 100 volts, 60 cycle current from light socket. It also can be supplied for 220 volt 2 and 3 phase, and in 110 and 220 volt direct current. E.P.R.

Swing frame grinder. ANON. *Abrasive Ind.*, **10** [4], 47 (1929).—A swing frame grinding machine was developed recently by the Kinney Iron Works, Los Angeles.

The grinder is suspended from an ordinary chain block, the suspension bracket being adjustable so that the device can be balanced correctly at all times. The motor is fully enclosed and is interchangeable, 2 or 3 phase, 220 to 440 volts, 50 or 60 cycle. It is fan-cooled and operates in ball bearings. E.P.R.

Selection of buffing materials. FREDERIC B. STEVENS. *Abrasive Ind.*, **10** [4], 48–52 (1929).—The condition of the surface to be buffed must always be considered in the selection of materials. The deepest scratches and the worst pits or imperfections determine the class of abrasive to be used. Tripoli compositions are the cutting agents on the softer metals while emery cake is used on steel, iron, and softer metals with poor surface. The finest possible grade of abrasive which will remove the blemishes with reasonable speed should always be used, as the cutting agents themselves leave scratches behind them. These scratches can scarcely be seen with the naked eye but they are very evident under the microscope, the depth of the scratches depending on the toughness, hardness, and sharpness of the abrasive as well as on the tensile strength or toughness of the metal. Where a high luster is required such products as a coloring composition or a lime composition must be used. These products have practically no cutting qualities and therefore the surface must be cut down and leveled off with fine emery, tripoli, or crocus composition before they can be successfully applied. No one product can possibly be both a fast cutter and producer of a high finish or high luster because a fast cutting abrasive will itself produce fine scratches. Plating will not remove scratches. The work must be smoothly polished before plating. A question of whether or not the article is to be cleaned in a cleaning solution, the type of cleaning solution, and whether or not it is to be plated have an important bearing on the abrasive to be used and the type of binder. The type and diameter of buffing wheel, its peripheral speed, and many other factors have a bearing on the right composition to use. E.P.R.

Polishing high grade shovels in quantities. ANON. *Abrasive Ind.*, **10** [4], 52–54 (1929).—The initial grinding operation on shovels consists of edging. It generally is performed on an alumina abrasive wheel. A hard wheel is necessary because the shovel edge exerts a dressing action on the wheel which tends to tear the abrasive grain away from the bonding material. The wheel should be operated at a peripheral travel of not less than 5000 ft. per min. E.P.R.

Clean abrasive grain promotes polishing efficiency. TORREY ALLEN. *Abrasive Ind.*, **10** [4], 54–56 (1929).—An aluminous polishing abrasive must be thoroughly clean and dry to give maximum results. Otherwise in setting up, it cannot be gripped at full strength by the glue and will be torn away before giving the fullest amount of production of which it is capable. Through their crushing and sizing stages, abrasives are liable to contamination by grease, moisture, and dust. The latter may be a finer abrasive but is no less detrimental. This condition must be corrected before the grain is shipped. Exact methods of cleaning abrasives vary among producers, but, broadly, they include both chemical and heat treatments which are designed to cut away the grease and to burn it off, to remove the dust, and to give a bone-dry product. An abrasive which passes the capillarity test allows the glue to get its maximum grip on it. A. outlines the care exercised by abrasive producers in providing a polishing room product to give maximum efficiency on set-up wheels and stresses the fact that polishing room foremen should use due care in handling abrasives so that the original efficiency will be unimpaired. E.P.R.

Increasing polishing room output. ANON. *Abrasive Ind.*, **10** [4], 56–58 (1929).—Polishing and buffing operations play an important part in the manufacture of articles that must present an attractive sales appearance. No matter how efficiently a unit is designed, or how carefully the materials entering into its manufacture are selected and worked up, "finish" must be present also. At the plant of the Buffalo Dental Mfg. Co.,

Buffalo, polishing and buffing operations are carried out with more than usual care. The polishing, plating, and buffing departments are in separate rooms on one side of the building so that natural lighting can be used almost exclusively. E.P.R.

Polishing wheel speeds. ANON. *Abrasive Ind.*, **10** [4], 58 (1929).—To obtain the best results, set-up polishing wheels should revolve with a surface speed of approximately 7500 ft. per min. In polishing small parts with small wheels the speed can be somewhat slower. Muslin wheels used for buffing generally are operated at peripheral speeds ranging from 8000 to 10,000 ft. per min. If polishing wheels are operated at excessive speeds, the glue will soften and if the speed is too slow, the grains will be torn away. In either case the result is inferior work and comparatively short wheel life. E.P.R.

Artificial abrasive of corundum. ANON. *Eng. Min. Jour.*, **124** [5], 183 (1927).—The new abrasive is made by heating natural corundum in an electric furnace. Natural corundum has almost double the percentage of Al_2O_3 that bauxite has. The corundum must be free as possible from titanium and must be very pure. A.J.M.

New abrasive wheel for disk type grinders. ANON. *Iron Age*, **119** [11], 791 (1927).—Instead of a paper disk glued to a steel plate, the new disk is a full-dimensioned abrasive wheel sulphured to the plate. A.J.M.

PATENTS

Internal grinder. WILLIAM L. BRYANT. U. S. 1,705,749, March 19, 1929. A machine of the class described comprising a vertically movable plunger, a vertical shaft journaled in the plunger, a grinding wheel carried by the upper end of the shaft, a work holder for supporting work in operative relation to the wheel, a shaft, an eccentric on the shaft, a lever engaging the eccentric at one end and the plunger at the other end, means for rotating the eccentric shaft to vibrate the plunger lengthwise, and means to move the fulcrum of the lever to rock the lever about the eccentric and move the plunger to remove the wheel from operative relation to the work carried by the holder.

Abrasive stone. GEORGE E. DRESSER. U. S. 1,707,472, April 2, 1929. As a new article of manufacture, an abrasive stone for use as a file for dressing the contact points of automobile ignition systems, consisting of a strip of abrasive stone of substantially uniform thickness of about $^1/_{16}$ inch throughout its length and which is thin enough to pass between the contact points of such ignition systems but not thick enough to withstand the use to which it is to be put without breaking, and a sheet metal reinforcing member of channel form closely fitting over one edge of the strip along substantially its full length, the reinforcing member extending over a small portion only of the width of the stone and being sufficiently thin so as not to interfere with the use of the stone in dressing the contact points of automobile ignition systems.

Buffing machine. ROBERT M. FOTHERINGHAM. U. S. 1,708,569, April 9, 1929. A buffing machine comprising a supporting frame, a rotatable chuck head, an annular row of chucks supported in the head and having pinions, a shaft carrying the chuck head, means for rotating the chuck pinions when they arrive at a certain station, and for intermittently rotating the chuck head shaft to bring the chucks in succession to the station, the means consisting of a continuously rotating shaft arranged parallel with the chuck head shaft, a pinion thereon to be engaged by the chuck pinions when at the station for rotating the chucks, a second pinion on the continuously rotating parallel shaft, a gear mounted coaxially with relation to the chuck head shaft rotated continuously from the second pinion on the parallel shaft, and means for transmitting motion from the continuously driven gear intermittently to the chuck head shaft, substantially as described.

Grinding worm gears. BENGT M. W. HANSON. U. S. 1,708,570, April 9, 1929. Method of grinding worm gears which consists in rotating, while in engagement, a worm

gear and an abrasive grinding worm having a spiral rib of less width than the spaces between the teeth of the work, and while in grinding relation imparting a motion between the work and wheel to relatively feed the worm and work tangentially of the latter.

Mechanism for truing and dressing grinding wheels. FERDINAND J. HOHNHORST. U. S. 1,708,575, April 9, 1929. In an abrading machine for grinding wheels, the combination of a frame, a rotary abrading part rotatable on the frame, a brake for the rotary abrading part, and a lifting handle for the machine acting by lifting movement thereof to apply the brake.

Abrasive and polishing tool. KINGSLEY M. BROWN. U. S. 1,708,603, April 9, 1929. The combination with an elastic ring, of an annular segmental member, interiorly engaging and supporting the ring and having a substantially conical interior surface, each segment of the member being formed with a rib upon one lateral face elongated in substantial parallelism with the conical surface and with a groove in its other lateral face receiving the rib of an adjoining segment, an exteriorly coned member interiorly engaging and carrying the segmental member, and means for moving the exteriorly coned member axially of the segmental member to expand the latter.

Portable boring and grinding machine. NELS A. NELSON. U. S. 1,708,798, April 9, 1929. A boring and grinding machine comprising a portable frame having a horizontal base and a vertical standard, a rotatable and slidable outer shaft arranged in the standard and adapted to carry a tool, a drive to rotate the outer shaft, an inner shaft arranged in the outer shaft to drive a tool and carried by the outer shaft, a rotary driver arranged alongside the outer shaft, a drive connecting the inner shaft and the driver and movable with the inner shaft along the driver, a feed screw arranged alongside the outer shaft, a feed nut threaded on the feed screw, a shaft support journaled on the nut and having a tongue and groove connection with the outer shaft to support the same, a toothed wheel arranged on the nut, and a pin carried by the outer shaft to engage successive teeth of the wheel and rotate the same as the outer shaft rotates to feed the outer shaft downwardly.

Grinding toothed gears. MAAG-ZAHNRÄDER UND MASCHINEN A.-G. Brit. 303,833, March 6, 1929. In a process for grinding gear wheels wherein preliminary rough grinding is followed by finish grinding with a finer feed, the rough grinding is stopped before the last few teeth on the wheel have been treated, and the grinding wheel is trued, after which the last few teeth are rough ground and the finish grinding then effected over the whole wheel. In this way the cutting power of the grinding wheel, which is increased by the truing operation, is allowed to fall to its normal value before the finishing stage commences. A spindle carries a ratchet wheel with a number of teeth which is a multiple of the number of teeth to be produced on the blank. At each dividing movement of the work the wheel is fed through one tooth by means of a pawl. On starting the machine the wheel will be rough ground first completely and then to the extent of 37 teeth. The arm will then come into action to stop the feed and generating movements and the wheel is then trued. The lever is operated by hand to restart the machine and after the remaining three teeth on the blank have been rough ground, the roller acts to change the feed so that the wheel is finish ground. At the end of this operation the stop comes into action to stop the machine again. For grinding small wheels, the grinding wheel need not be sharpened toward the end of the roughing operation and in this case the arm may be put out of action by shifting the stop.

Centerless grinding machines. V. A. B. HUGHES. Brit. 304,060, March 6, 1929. In a centerless grinding machine, the work pieces are presented to opposed grinding and regulating wheels by means of a rotating carrier which steadies the work pieces but allows freedom for their automatic adjustment on the work-rest and the periphery of the grinding wheel. The grinding wheel has a peripheral arcuate groove and the regulating

wheel is mounted on a slide adjusted by a screw which is connected by lever mechanism to a rotary cam to impart reciprocating movement to the regulating wheel in order to feed the blanks to the grinding wheel. Another slide carries a bracket provided with a work-rest which projects between the grinding and regulating wheels and supports the spherical heads of the work pieces during the operation. The grinding wheel rotates downwardly toward the work-support while the regulating wheel is moved slowly upwardly to rotate the work by frictional contact. The work carrier comprises a disk rotating on a spindle and provided with peripheral openings to receive the shanks of the work pieces.

Grinding razor blades. S. GILLESPIE. Brit. 304,494, March 20, 1929. A machine for grinding razor blades comprises rotatory members provided with pins and coacting with tensioned steel bands to carry the blades past a number of grinding wheels.

Centerless grinding machines. V. A. B. HUGHES. Brit. 304,502, March 20, 1929. In a centerless grinding machine the work guide makes contact with the surface of the work along a helical or other inclined line so that the points of contact become progressively nearer the grinding wheel or vary progressively in some other manner as the work is traversed axially through the machine. The machine comprises a grinding wheel rotated by a belt and adjustable jockey pulleys from a shaft and a regulating wheel also rotated from the shaft.

Grinding toothed gears. C. D. P. SMALLPEICE. Brit. 304,836, March 20, 1929. In a gear-grinding machine of the kind in which the work is rolled relatively to a reciprocating grinding wheel of rack-tooth section to generate the tooth profile, the indexing mechanism is controlled by the combined action of the two reciprocating slides carrying the work and grinding wheel, respectively. The blank is mounted on a spindle carried in a headstock which may be traversed across the bed to impart the generating movement by hydraulic power. Corresponding rotary movement is imparted to the blank to give correct rolling by means of flexible band mechanism comprising steel tapes passing over a drum on a tubular shaft. One end of each band is secured to a plate keyed to the drum and the other ends are respectively secured to two reels fixed to a vertically-adjustable bracket mounted on the machine bed. The grinding wheel driven by a belt from a pulley is mounted on a vertically-adjustable slide carried by a saddle which is reciprocated axially of the gear teeth preferably by hydraulic gearing. To index the work the bolt is withdrawn while the grinding wheel is clear of the work by means of trip mechanism actuated by the saddle and acting through a link on a shaft.

Grinding toothed gears. GEAR GRINDING CO., LTD., A. H. ORCUTT, AND J. W. SNARRY. Brit. 304,917, March 27, 1929. In a machine for grinding tooth gears and the like wherein a grinding wheel is mounted on a reciprocating slide while the gear blank is mounted on an indexable spindle and is fed transversely on a slide to give the required tooth depth, the gear blank feed is interconnected with mechanism for feeding a truing mechanism up to the grinding wheel so that an indication is given to the machine attendant of the effective relative feed movement between the grinding wheel and the work. The feed mechanism for the truing tools comprises a slide fed by screw and nut gearing operated from a hand-wheel through a shaft and worm gearing. The shaft also drives through a worm an annular disk carrying an index mark. A graduated disk mounted coaxially with the annular disk is rotated through gearing from a shaft connected by bevel gearing to the feed spindle of the work-slide, this spindle being rotated from a bend wheel through a gearing.

Art

International exhibition of ceramic art. JOSEPH BRECK. *Bull. Met. Mus. Art*, **23** [9], 210–12 (1928); C. LOUISE AVERY. *Ibid.*, [10], 232–38 (1928); see *Ceram. Abs.*, **7** [12], 806 (1928). A.A.A.

Johnson collection of porcelains. ANON. *Int. Studio*, **92** [383], 52–54 (1929).—Illustrations and descriptions of rare ancient Chinese ware. E.B.H.

Adelaide Alsop Robineau. S. E. ROBINEAU. *Design*, **30** [11], 201–209 (1929).—A story of the aims and development of Mrs. Robineau's porcelains, with many illustrations. Specializing in elaborately carved porcelains of varied shapes, one of the greatest achievements of her skill and patience was the incised egg-shell coupes, of almost paperlike thinness. Another famous piece is the Scarab vase. See also *Bull. Amer. Ceram. Soc.*, **8** [5], 121 (1929). E.B.H.

Modern art glass. W. E. S. TURNER. *Glass*, **6** [2], 61 (1929).—This is an abstract of a paper read at the Glass Convention, Bournemouth, Sept., 1928. Glasses from England, France, Germany, Czechoslovakia, Sweden, and the U.S. are discussed. A.J.M.

Spraying equipment in the glass industry. ANON. *Glass*, **6** [2], 62 (1929).—Spraying is now a recognized method of applying decorations to glassware. The most important advance has been the development of the sprayer nozzle to produce at will either a concentric formation of spray, or a flattened spray with which much larger areas could be covered at one sweep of the sprayer, a continuous band of color 14 in. or more in width being obtained with the latest apparatus. Careful design and accurate construction of the nozzle mechanism are necessary in order to obtain uniform distribution over a large surface. An important advance has been made in the evolution of the automatic spraying machine, the details of which are described. A.J.M.

Mexico's handicrafts. BEATRICE MILLER WISNER. *Crockery and Glass Jour.*, **107** [3], 58 (1929).—Spanish influence has strongly characterized Mexican ware and old motifs and designs which have been handed down through the ages. History reveals the art of glassmaking in Spain which for many centuries has competed successfully with that of Italy, which in the early 13th and 14th Centuries proved its greatest achievement. The finest glass blowers produced quantities of excellent glass pieces which were exported to Rome. Some of the earlier glass was ornate in character with profuse decorations, handles, etc. In Barcelona the dark green thin glass was produced for many hundreds of years. For 300 years glass blowers of Mexico have been working in hand-formed and breath-blown glass, but only within recent years have their efforts been recognized as commercially valuable. The quaintness of Mexican glass and its peculiar fascination lies in its oddity of shape, texture, reacting color tones, and the little bubbles running through it. Mexican pottery is made by the old primitive kick-wheel method. The more common ware includes unglazed pieces, such as wine and water jugs, cooking utensils, and large jars. The original pottery is best suited for porticos and gardens. E.P.R.

Native Mexican pottery. ANON. *Crockery and Glass Jour.*, **107** [3], 55 (1929).—The enlivening colors that predominate in the hand decorations of Mexican pottery have stimulated the value of the various objects which are finding their way to many homes in the U.S. E.P.R.

Color in modern glassware. G. A. SEABURY. *Crockery and Glass Jour.*, **107** [3], 41 (1929).—The modern color craze has extended to glass and china. The most popular hues in stemware are green, rose, and amber, with deep azure blue and the paler "moonlight blue," and the new color variously called topaz (which it resembles) or canary yellow. E.P.R.

Modern art for ceramics. MYRTLE M. FRENCH. *Crockery and Glass Jour.*, **107** [3], 82 (1929). E.P.R.

Stained glass for Washington cathedral. ANON. *Nat. Glass Budget*, **44** [48], 18 (1929).—Provision is made in Washington cathedral for three great rose windows to represent the creation, the end of the world, and the life of the world to come. In the

nave of the cathedral there will be three tiers of windows on the south and three tiers on the north side to represent the course of Christian history. E.P.R.

Ceramics glorified. ANON. *Pottery, Glass, and Brass Salesman*, **39** [8], 17 (1929).—Showings of new styles by home manufacturers and importers indicate resourcefulness of both potter and glassmaker in keeping pace with demand. E.P.R.

Plants of the S. A. Weller Pottery Co. ANON. *Ceram. Ind.*, **12** [4], 442–46 (1929). F.P.H.

Decalcomania transfer machine. ANON. *Ceram. Ind.*, **12** [4], 453 (1929).—A decalcomania transfer machine has been built at an enameling plant for applying decoration on small pieces in order to eliminate the hand rolling operation. It is a foot operated press having a spring attached to the pedal. The piece on which the decoration is to be placed is sized with the usual adhesive and the transfer applied. It is set on a flat plate, and a plunger which has an end fitted with a felt pad, descends, pressing the transfer onto the piece. The end of the plunger consists essentially of a noncorrosive rectangular plate having a fiber plate fastened to it by two flathead bolts with wing nuts. Muslin cloth holds a felt pad to the under side of the fiber piece. The pad is moistened by pressing downward on a second wet one, thus absorbing enough water to last for two or three hours. After stamping, the spring pulls the plunger upward. Surface tension holds the piece to the upper plate, and may be easily removed with the thumbs. It is then placed in a water trough and the transfer paper allowed to soak. The paper is removed and the piece is placed on a rack, which is set into a drier when filled. It is said that 250 to 300 pieces may be decorated and put into the drier by one person in an hour. F.P.H.

Meissen porcelain. ERNST ZIMMERMANN. *Keram. Rund.*, **35**, 138–43 (1927).—A comparison of the older and newer methods and motifs of the artists in the Meissen Porcelain Manufactory. Illustrations of figurines and chinaware are given. H.I.

Additive and subtractive color mixing and decolorization. HERBERT SCHÖNBORN. *Sprechsaal*, **61** [22], 432–34 (1928).—Color mixing according to triaxial diagram. R.A.H.

Art and authenticity. F. J. MATHER, JR. *Atlantic Monthly*, March, 310–20 (1929).—The forgeries of the contemporary Roman artist, Alceo Dossena, indicate that prominent museums make capital purchases without archaeological checks of any sort. The Metropolitan Museum alone in this country proved that its expert advice was an adequate defense against the Dossenas. As a cure for forgeries M. suggests the establishment of a great museum of forgeries of all periods. H.H.S.

Celtic pottery. ANON. *Evening News*, Feb. 27, 1929.—Unique pottery of the 5th Century B.C. was found near the fortress of Metz when excavating for drainage. The British Museum has acquired three pieces which are said to be the only ones in any museum in the world. H.H.S.

The Portland vase. E. J. FORSDYKE. *Illust. London News*, **174**, 136–37 (1929).—The Portland (or Barberini) vase, a historic work of deep blue Roman glass of the 1st Century, has been in the British Museum on loan for 118 years. In 1845 the vase was willfully smashed to pieces by a lunatic, but was put together so skillfully as to lose very little of its beauty. It was found within a marble sarcophagus in a tomb under Monte del Grano, near Rome. The figures on it are believed to represent the marriage of Peleus and Thetis. Illustrated. H.H.S.

Discoveries at Athens. A. BRUECKNER. *Illust. London News*, **174**, 389 (1929).—The German Archaeological Institute at Athens has uncovered the Dipylon, the main city gate of Athens, and its vicinity. The remains of a potter's kiln and enormous quantities of "throw-outs" from the kiln were found. Keramcikos Street was also opened up, and a granary with clay jars was found. H.H.S.

The elephant in Persian pottery. R. KOECHLIN AND G. MIJEON. *Illust. London News*, **174**, 401 (1929).—Illustrates the elephant design in 12th Century pottery from Rhages, the old capital of Persia. H.H.S.

Celtic masterpieces discovered in Lorraine. REGINALD A. SMITH. *Illust. London News*, **174**, 472–73 (1929).—Illustrates the finds made last year at Bouzonville, near Metz, of Graeco-Celtic flagons dating from 450 B.C. The British Museum is acquiring the vessels as representing the origin of a Celtic style that culminated in Irish masterpieces 12 centuries later. H.H.S.

Early Chinese pottery. ANON. *Illust. London News*, **174**, 484 (1929).—Seven photographs of ware from the exhibition held in London at the Bluett galleries. H.H.S.

Mimbres ware: American prehistoric pottery. ALBERT E. JENKS. *Illust. London News*, **174**, 543 (1929).—The Minneapolis expedition led by J. to the valley of the Mimbreños in N. Mex. found pottery in which the precision of workmanship is quite as remarkable as the variety of design. The clean-cut treatment of border-lines seems almost impossible without machines, and in the deeper bowls it is hardly credible that the artist could handle his brush in the cramped position without faltering. Illustrated. H.H.S.

History recorded on china plate. ANON. *Mentor*, **17** [1], 62 (1929).—A plate of modern Wedgewood was made in England under the auspices of a mid-west chapter of the Daughters of the American Revolution in memory of the pioneer, George Rogers Clark. Bearing the garland border that the Wedgewood company has used for over 100 years on its historic subjects, the plate depicts the surrender of the British stronghold, Fort Sackville, at Vincennes, Ind., Feb. 24, 1779. The scene, taken from the painting of the American artist Frederick Yohn, shows the English general, Hamilton, handing over his sword to Clark in front of the blockhouse. E.J.V.

Swedish engraved crystal glass. THORSTEN THORSTENBERG. *Mentor*, **17** [3], 15–17 (1929).—An illustrated discussion of the famous Orrefors glass produced from designs supplied by two well-known artists, Simon Gate and Edward Hald. Under their guidance the handicraft of engraving crystal glass has been developed into an art. E.J.V.

Delft pottery. F. W. HUDIG. *Pottery Gaz.*, **54** [622], 589 (1929).—Delft ware really originated in China and its development is traced through Persia, Spain, Italy (where it became majolica), France, and finally Holland. Here it was made of earthenware with all the colors which the original Chinese porcelain had. In the 17th Century Chinese porcelain was being imitated by the production of a very thin ware covered with a white glaze, so that it was hard to distinguish it from the real porcelain. The material was softer, but as that could be observed only when it was broken, the imitation was just like the original China porcelain. The reasons for Delft becoming the center of the industry are advanced. Imports of Chinese porcelain and competition from Japan are discussed. The manufacture of Delft ware in England and other countries led to the shutting out of the genuine Delft and then to the competition between the products of these other countries and the Dutch Delft ware. The entrance of Wedgwood into this field with his ware brought about the gradual change from manufacture of Delft ware to the manufacture of English earthenware, which was harder, stronger, more resistant to fire, acids, and salts, using English materials for the purpose, and introducing the methods adopted by Wedgwood in England. E.J.V.

BOOK

Art in Ancient Rome. EUGENIE STRONG. Wm. Heinemann, Ltd., London, 1929. 2 vols., price 10*s* each.—Begins with primitive Etruria and ends in Byzantium. H.H.S.

PATENTS

Design for plate or similar article. JOHN V. GODDARD. U. S. 78,017, March 19, 1929.

Designs for plates or similar articles. URASABURO TOMITA. U. S. 78,945–57, March 19, 1929.

Design for plate or similar article. HAROLD E. NOCK. U. S. 78,119, March 26, 1929.

Design for plate or similar article. WILLIAM HORACE STEVENTON. U. S. 78,230, April 9, 1929.

Design for plate or similar article. CHARLES WEISS. U. S. 78,241, April 9, 1929.

Design for bottle. IRVING W. BEAN. U. S. 78,002, March 19, 1929.

Design for bottle. SAMUEL LANCET. U. S. 78,110, March 26, 1929.

Design for bottle. ERIC URQUHART BINKS. U. S. 78,140, April 2, 1929.

Design for bottle. JOSEPH GLAZER. U. S. 78,157, April 2, 1929.

Design for bottle. LEONARD B. KRICK. U. S. 78,163, April 2, 1929.

Design for bottle. GEORGE N. MAS. U. S. 78,167, April 2, 1929.

Design for bottle. LEON A. DANCO. U. S. 78,194, April 9, 1929.

Designs for goblets. JULES H. VENON. U. S. 78,058–60, March 19, 1929.

Design for tumbler. GEORGE S. DUNBAR. U. S. 78,014, March 19, 1929.

Design for cup. CHARLES WEISS. U. S. 78,240, April 9, 1929.

Design for handle of cup. CHARLES WEISS. U. S. 78,238, April 9, 1929.

Designs for covered dishes. JACQUES BERNARDAUD. U. S. 78,079 and 80, March 26, 1929.

Design for covered dish. JOHN V. GODDARD. U. S. 78,201, April 9, 1929.

Design for covered dish. CHARLES WEISS. U. S. 78,239, April 9, 1929.

Design for electric bulb. GODFREY NIEBEL. U. S. 78,120, March 26, 1929.

Design for cooking stove. HERMAN HERRENBRUCK. U. S. 78,026, March 19, 1929.

Decorating glass surfaces. KALMAN WARGA. U. S. 1,705,512, March 19, 1929. An attachment to glass annealing leers including a mechanism for transferring printed labels from a stack to the interior of a hot mold, each label having applied to one of its faces a design of a mineral pigment and flux and on its other face an adhesive which is adapted to be rendered operative by heat, the mechanism comprising a casing having a perforated surface conforming in configuration to that portion of the interior surface of the mold to which the label is to be applied, and suction-operated means connected to the casing which, when in operation, causes the label to adhere with its design bearing face to the perforated surface of the casing and to assume the shape which it is to take in the mold, the adhesive on the label being exposed to be brought into contact with the interior heated surface of the mold to be left thereon when the suction operating means is rendered inoperative.

Glazing pottery. LOVATT AND LOVATT, LTD., AND A. E. LOVATT. Brit. 303,679, Feb. 27, 1929. Relates to the method of pottery decoration in which coloring matter such as broken glass or other colored glaze, is deposited on the surface of the ware and is made to adhere by glaze firing. According to the invention, the coloring matter, crushed to particles of the required size, is subjected to an initial firing and is subsequently mixed with the raw of fritted glaze, and the mixture is applied to the ware and fired. By first firing the colored particles, they do not dissolve in, and become indistinguishable from the glaze but remain in suspension.

Cement, Lime, and Plaster

Relation between the temperature curve and the expansion curve in the setting of plaster. F. J. WILLIAMS AND F. C. WESTENDICK. *Jour. Amer. Ceram. Soc.*, **12** [5],

377–81 (1929).—The plan of the investigation was to determine the relation between the expansion curve and the temperature curve in the setting of plaster of Paris, which is manufactured by calcining gypsum at about 145°C in muffle or rotary cylinders. The setting of plaster results from the fact that when it is mixed with water the latter dissolves some of the hemihydrate which unites with the water to form the dihydrate. The first volume change is a contraction followed by expansion, due to the fact that the calcium-hemihydrate ($2CaSO_4$-H_2O) goes into solution, thus decreasing the volume. An equilibrium is reached when the solution is saturated and then the dihydrate ($CaSO_4$-H_2O) crystallizes out, causing expansion. Apparatus, methods of testing, data, calculations, and curves are given.

Cement in 1927. B. W. BAGLEY. Bur. Mines, *Mineral Resources of the U.S.*, Part II, pp. 269–98 (1928).—The Portland cement produced in 1927 was the largest quantity manufactured in any year and amounted to 173,206,513 bbl. There were shipped from the mills 171,864,728 bbl. valued at $278,854,647, an increase of 6% in quantity and 0.3% in gross value. The average factory value per barrel decreased 9 cents. The stocks on hand at the end of the year were 6% greater than those at the end of 1926. Tables are given showing the production and shipment of Portland cements by states, monthly production by districts, domestic consumption, local supplies, prices. Sections are included on manufacturing methods, special cements, masonry, natural and pozzuolana cements, and imports and exports. R.A.H.

Modern Portland cement plant. JOHN J. LANDY. *Cement, Mill, and Quarry*, **33** [4], 6–13 (1928).—The history and development of Keystone Portland Cement Co., Bath, Pa., together with a detailed description of the quarry and plant equipment are given. E.P.R.

Germans to build Russian cement plant. ANON. *Cement, Mill, and Quarry*, **33** [4], 46 (1928).—A contract for a cement plant with an annual capacity of about 2,000,000 bbl., to be built near Novorosiska in the Ukraine, has been awarded by the Russian Government to the Friedrick Krupp A.-G. E.P.R.

Cement plant sold. ANON. *Cement, Mill, and Quarry*, **34** [4], 21 (1929).—Northern Salvage Co., Grayling, Mich., purchased the cement plant of the Peerless Egyptian Cement Co., Youngstown, Ohio, located at Fenton, Mich. E.P.R.

Opposition to state cement mills. ANON. *Cement, Mill, and Quarry*, **34** [4], 53 (1929). E.P.R.

Carolina cement mill. ANON. *Cement, Mill, and Quarry*, **33** [4], 77 (1928).—Plans have been completed for the proposed plant of Carolina Cement Co., of New Bern, N. C. E.P.R.

Tariff on Canadian cement. ANON. *Cement, Mill, and Quarry*, **33** [4], 65 (1928).—Collectors of customs have been instructed by the U. S. Treasury Dept. to assess duty on Canadian cement in bags at the rate of 8c per 100 lb. gross weight, plus a duty of 20% *ad valorem* on the bags. This is in the nature of a countervailing duty. E.P.R.

Heat consumption of gas-fired lime kilns. H. HAELBIG. *Arch. f. Wärmewirt. u. Dampfkesselwesen*, **9** [5], 143–44 (1928); *Rock Prod.*, **32** [6], 94 (1929).—H. presents operating data on burning lime with pit-coal gas, precautions for reducing heat losses, and test results on firing blast-furnace gas and brown coal gas. F.P.H.

Theories concerning hydraulic limes and cements. M. J. MERCEROU-VICAT. *Le Ciment*, **5**, 182–86 (1928); *Rock Prod.*, **32** [7], 101 (1929).—M. outlines the scientific development of the theories of hydraulic limes and cements, with special consideration of French investigators, starting with the first work of Louis Vicat in 1817. F.P.H.

Effect of diatomaceous earth on Portland cement mixtures. ALTON J. BLANK. *Rock Prod.*, **32** [6], 81–82 (1929).—While increase in strength values of some cements is had through the addition of pulverized silica, other cements are very little benefited, if

at all. This fact may be explained in part as follows: In correctly proportioned cements where there is present sufficient available silica for combination with all of the lime in the sintering process, the percentage of free, or uncombined lime, in the cement is very small. An addition of pulverized silica to a cement of this nature tends to increase the strength value of the cement very little, if at all. F.P.H.

"Portland jurament." ANON. *Tonind. Ztg.*, **52** [68], 344 (1928); *Rock Prod.*, **32** [7], 100 (1929).—This is a cement produced by a German plant from Portland cement clinker, blast-furnace slag, and schist slag. In 1913 Schmitt reported that by adding schist slag or unburned gypsum, the setting period of cements may be prolonged at will; but whereas gypsum offers the danger of swelling, schist slag does not. Research done since the World War showed that an addition of schist slag up to about 30% does not decrease the compressive strength, but that it rather increases it above that of normal Portland cement. The official investigations at the Materials Testing Institute of the Higher Technical School, Stuttgart, in the years 1926–27 showed the following comparative values:

Storage test	Portland cement compressive strength (kg./sq. cm. and lb./sq. in.)	"Portland jurament" compressive strength (kg./sq. cm. and lb./sq. in.)	Portland cement tensile strength (kg./sq. cm. and lb./sq. in.)	"Portland jurament" tensile strength (kg./sq. cm. and lb./sq. in.)
(*a*) 1 day, damp air 6 days, water	230 (3271)	230 (3271)	23 (327)	21.7 (308.6)
(*b*) 1 day, damp air 6 days, water 21 days, damp air	390 (5547)	432 (6145)	43 (612)	31.5 (448)
(*c*) 1 day, damp air 27 days, water	320 (4551)	420 (5974)	29 (412.7)	47.5 (698)

F.P.H.

Disintegration of clinker from rotary tube kilns during storage. A. SPENGEL. *Tonind. Ztg.*, **52** [97], 1939–40 (1928); *Rock Prod.*, **32** [7], 100 (1929).—S. tested well-sintered clinker from rotary kilns which had been stored in wooden barrels and unprotected from air for about seven years making screening and quality tests in respect to granulation and weathering, and chemical analyses of the disintegrated residue. S. concludes that, due to the higher lime content of disintegrated matter or residues, particularly when storing in clinker bins, care should be taken in using such residue in cement production. F.P.H.

Testing standards of cements produced in 1927 in Czechoslovakia. ANON. *Zement*, **17** [28], 1036–38 (1928); *Rock Prod.*, **32** [7], 101 (1929).—Every year the mechanical technical testing laboratory of the German Higher Technical School in Prague secures a certain number of different makes of cements in the trade and tests them to compare their characteristics with the cement standards. The results for 1927, as given in several tables and diagrams, and amplified, include 13 makes of cement. F.P.H.

Development of the Polish cement industry. ANON. *Zement*, **17**, 1355 (1928); *Rock Prod.*, **32** [7], 100 (1929).—The Polish cement industry has available the 500 sq. km. (1931 sq. mi.) Jurassic chalk formation of the Cracow-Czernichow Pass extending to Wielun; the so-called shell lime deposits of about 200 sq. km. (772 sq. mi.) in the Silesian district toward Olkusch, usually in mixture with coal layers; tremendous chalk and marl deposits in the Weichsel and Bug valley; and minor deposits of sedimentary marl. F.P.H.

Mortar and mortar colors. ANON. *Clay-Worker*, **91** [3], 265 (1929).—Manufacturers of brick or hollow tile seldom produce mortars or mortar colors, even though they play an important part in the industry. In the research work on brick and tile, mortars are used, and the information gained should be passed along to the dealers so that they may be informed on what constitutes the best kind of mortar for any given kind of work. The clayworking industry should inform the dealers and prospective

builders of the importance of colors in mortars and in improving the architectural beauty of face work. E.J.V.

Some new moduli and indices relating to main hydraulic components of Portland cements. I. SHOICHIRO NAGAI. *Jour. Soc. Chem. Ind., Japan*, **32** [3], 73B (1929).—In comparing the results of strength tests of 1:3 cement sand mortars of many Portland cements, it is hardly possible to obtain any close relation between strengths and hydraulic modulus ($CaO/(SiO_2 + Al_2O_3 + Fe_2O_3)$), silica modulus ($SiO_2/(Al_2O_3 + Fe_2O_3)$), index of activity ($SiO_2/Al_2O_3$), iron modulus ($Al_2O_3/Fe_2O_3$), etc., these indices and moduli being mere weight ratios of total silica, alumina, iron oxide, lime, etc. It is more nearly possible to do so with the lime factor ($CaO/(2.8SiO_2 + 1.1Al_2O_3)$), cementation index ($(2.8SiO_2 + 1.1Al_2O_3 + 0.7Fe_2O_3)/(CaO + 1.4MgO)$), index of activity ($2.8SiO_2/(1.1Al_2O_3 + 0.7Fe_2O_3)$), etc., considering the conditions of combinations of these main hydraulic components, but they never express useful relations between them and strengths of mortars. N. discusses these moduli and indices by comparing many results of the strength tests and calculated values of many Japanese and foreign Portland cements. **II.** *Ibid.*, **32** [3], 73–74B (1929).—N. proposes some new moduli and indices relating to main hydraulic components of cements and calculates their values by using the results of chemical analyses of many Japanese and foreign Portland cements in the first paper, to compare those values with the strength tests of 1:3 cement sand mortars. Some of the newly proposed moduli and indices have the following formulas:

l: lime silica ratio or lime silica combining ratio =

$$\frac{CaO - (1.65Al_2O_3 + 0.70Fe_2O_3 + 0.70SO_3 + \text{free CaO})}{SiO_2 - 0.80 \times \text{insoluble residue}}$$

m: lime silica molar ratio $= 1.07 \times l =$

$$1.07 \times \frac{CaO - (1.65Al_2O_3 + 0.70Fe_2O_3 + 0.70SO_3 + \text{free CaO})}{SiO_2 - 0.80 \times \text{insoluble residue}}$$

Molar ratio of tricalcium silicate to dicalcium silicate =

$$\frac{\text{Molar \% of } 3CaO{\cdot}SiO_2}{\text{Molar \% of } 2CaO{\cdot}SiO_2} = \frac{m - 2.0}{3.0 - m}$$

(See "Relations between Composition and Strength of Mortar on Combined Hardening," *Ceram. Abs.*, **8** [1], 16 (1929).) Means of 8 recent Japanese Portland cements and 5 early high strength Portland cements of foreign make were plotted on the diagram of a ternary system. Three components CaO, SiO_2, and Al_2O_3 of the system were calculated by the following formulas:

(1) CaO by total $CaO - (0.70\ SO_3 + \text{free CaO})$
(2) SiO_2 by total $SiO_2 - 0.80 \times$ insoluble residue
(3) Al_2O_3 by $Al_2O_3 + Fe_2O_3$.

By means of this ternary diagram, merits and demerits of many cements of low-silica and high-silica types of Japanese and foreign Portland cements were clearly discussed. E.J.V.

Limiting concentrations in the formation of Sorel cement. L. L. JESSER. *Pit and Quarry*, **17** [10], 57–60 (1929).—Mortar composed of 100 parts by weight of burnt caustic magnesite, 33 parts by weight of sawdust, and magnesium chloride solutions of 14, 17, 20, and 23°Bé. concentrations will give the following results. The mortars are allowed to set in the normal way containing just their own amount of water.

Tensile Strength of Sorel Cement Mortar in Kilograms

Time allowed to remain, days	Mortar A			Mortar C		
	Solutions used to make mortar, strength in degrees Bé.					
	17	20	23	14	17	20	23
3	8.4	13.6	30.0	9.2	14.2	21.4	32.2
7	10.8	20.0	36.4	12.1	18.4	24.6	38.4
28	13.2	24.2	38.6	13.2	22.4	35.5	43.6

The water-vapor pressures in the mortar were also studied and when these observations are connected with the afore-described development of strength while the mortars are allowed to remain in a box shut off from the external air, then it is seen that the limiting concentration of the increase in tension divides two stages of the development of strength in the mortar. R.G.E.

Colored Portland cements. ANON. *Pit and Quarry*, **17** [11], 46 (1929).—British patents cover the making of colored cements from pigmented raw materials by the addition of pigments, such as oxides of chromium, nickel, cobalt, and copper, together with such salts as metallic halogen compounds, phosphates, and borates which combine with the pigment to form colored melts on heating. R.G.E.

Action of calcium sulphate on the mechanical properties of cement. P. P. BUDNIKOFF AND W. M. LESCHOEFF. *Pit and Quarry*, **17** [11], 47–51 (1929).—This article is the report of an investigation undertaken at the Charkow Technological Institute, Russia, of the effects produced on the various mechanical properties of Portland cement by the addition of various modifications of calcium sulphate. Both anhydrous or dead-burnt gypsum as well as the dihydrated variety of gypsum were used in the experiments. The proportion of gypsum used ranged from 0.5 to 20%. A supercement was used as the starting material. The best results were obtained with a mixture containing Portland cement and 4% of dihydrated gypsum. The 4-, 7- and 28-day tensile strengths were 39.9, 57.1, and 68.2 kg. per sq. cm., respectively. Good results were also obtained with a mixture containing Portland cement and 2% of the insoluble anhydrite. The strengths in tension were 40.6, 46.0, and 56.8 kg. per sq. cm. The samples prepared with 2% dihydrate gave strengths in compression of 392, 549, and 590 kg. per sq. cm. The compressive strengths with mixtures containing 3% insoluble anhydrite were 510 and 730 kg. per sq. cm. for the 7- and 28-day tests, respectively. The mechanical strength of test samples prepared from pure Portland cement was less than those obtained on mixtures containing gypsum in almost every instance. Tables and curves are given showing tensile and compressive strengths and time of setting for the different test samples. R.G.E.

Wet process cement plant on Neville Island. W. E. TRAUFFER. *Pit and Quarry*, **17** [13], 67–71 (1929).—The Davison Coke and Iron Co. of Pittsburgh, Pa., is building a new 1,250,000 bbl. wet-process slag cement plant at Neville Island, Pa. This plant is of unusual interest because a blast-furnace and a by-product coke plant are to be operated in connection with it. These are now under construction adjacent to each other. This combination of industries was decided upon because (1) a blast furnace cannot be operated economically unless by-product coke is manufactured in connection with it; (2) the biggest factor in the operation of a by-product coke plant is the disposal of the gas produced. It was therefore decided to build a cement plant which would use up the slag from the furnace and the excess gas from the coke ovens. The fact that coal can be obtained very cheaply by boat will also add to the economy of these operations and was one of the reasons why the site at Neville Island was chosen. R.G.E.

Distribution of cement. ANON. *Pit and Quarry*, **17** [13], 82 (1929).—Figures are given showing the shipments of Portland cement mills distributed among the states

to which cement was shipped during December, 1927 and 1928, and January, 1928 and 1929. R.G.E.

Statistics on cement. ANON. *Pit and Quarry*, **17** [13], 82 (1929).—The ratio of the operations to the capacity of the American Portland cement industry during the month of February was 44.8%. During the month 8,522,000 bbl. were produced, 5,448,000 shipped, and 29,871,000 in stocks on hand. Production was 3.1% less and shipments 17.0% less than in February 1928. Stocks at the mills were 9.2% higher than a year ago. R.G.E.

Production, shipments, and stocks of Portland cement from 1927 to 1929. ANON. *Pit and Quarry*, **17** [13], 82, 83, 88 (1929). R.G.E.

Production and stock of clinker in 1927 and 1928. ANON. *Pit and Quarry*, **17** [13], 82, 87 (1929). R.G.E.

Exports and imports of hydraulic cement from 1927 to 1929. ANON. *Pit and Quarry*, **17** [13], 83, 87 (1929). R.G.E.

Gypsum in 1927. R. M. SANTMYERS AND JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources of the U.S.*, Part II, pp. 113–28 (1928).—Diversification of products continues to be the outstanding feature of the gypsum industry. This movement has been so vigorous that the production of crude gypsum has more than doubled within the last 10 yrs. The quantity of crude gypsum mined in the U.S. in 1927 was 5,346,888 short tons, a decrease of 288,553 T. or 5% compared with 1926. The value of sales of uncalcined and calcined gypsum by producers was $42,174,454 as compared with $46,721,219 in 1926, a decrease of 10%. In 1927, N.Y. was again the largest producer of crude gypsum with 11 active plants reporting 1,675,501 T., as compared with 11 plants reporting 1,723,460 T. in 1926. The pamphlet includes data on kettles and kilns in operation, prices and markets, imports and exports, new companies and corporations, plant increases, new products, future of the industry, and synthetic gypsum. A section is devoted to Canadian plants and production. R.A.H.

Progress in gypsum industry in Canada. L. H. COLE. *Cement, Mill, and Quarry*, **33**, [4], 26 (1928).—Gypsum is mined or quarried in Nova Scotia, New Brunswick, Ontario, Manitoba, and British Columbia, and each of these provinces has other properties capable of furnishing high grade material when market conditions warrant. The value for the total output for 1927 shows an increase of nearly $500,000 over that of the previous year. The output of crude rock in the maritime provinces shows a decided increase, but probably the most important developments in this industry have taken place in the products manufactured from gypsum. E.P.R.

Gypsum in Ontario. ANON. *Can. Chem. Met.*, **13** [3], 21 (1929).—The Canada Gypsum and Alabastine, Ltd., was the only company in operation in 1928. The total production of gypsum of various grades in 1928 was 85,811 T. valued at $553,271 compared with 83,998 T., worth $500,688, in 1927. The grades in 1928 were as follows: crushed, 20,675 T.; fine-grained, 1134 T.; calcined, 4133 T.; and 59,869 T. consumed in manufactured products such as insulex, plaster board, gyproc, etc. E.J.V.

Northwest gypsum doubles plant capacity. ANON. *Cement, Mill, and Quarry*, **33** [4], 47 (1928).—The gypsum and plaster plant of the U. S. Gypsum Co., near Heath, Mont., purchased last year by the Gypsum Products Co., will soon double its capacity and the force of men employed. E.P.R.

Gypsum and anhydrite retarders for cement. ANON. *Cement, Mill, and Quarry*, **34** [4], 41 (1929).—Investigation of the fundamental factors involved in the utilization of various forms of calcium sulphate as retarders for Portland cement is being continued at the Nonmetallic Mineral Experiment Station at New Brunswick, N. J. Plaster of Paris, gypsum, and anhydrite differ greatly in their retarding properties and give

different plasticities to the resulting products. Anhydrate can be used alone only under certain peculiar circumstances, although it is satisfactory in mixtures with other calcium sulphates. The results to date have been prepared for publication as a technical paper. One of the important factors shown by this investigation is the degree of fineness to which the cement and the retarder are ground. This has not been thoroughly investigated heretofore. The New Brunswick station is constructing apparatus for the separation of finely ground cement, gypsum, and anhydrite into fractions of definite particle size, using the air classification method preparatory to studying the time of set of the various fractions of typical Portland cements as compared with the time of set of these same fractions when mixed with various percentages of gypsum or anhydrite of definite particle size. E.P.R.

Determining quality of gypsum. W. SCHAPER. *Tonind. Ztg.*, **52** [96], 1923–24 (1928); *Rock Prod.*, **32** [7], 100–101 (1929).—The gypsum manufacturer should be able to determine in what manner the gypsum was made, whether by boiling (in kettles), burning (in shafts or furnaces), or in the rotary kilns; what burning temperature, burning period, and nature of influence of the heat; whether the firing temperature was maintained constant, increasing or decreasing. To make the quality test, gypsum is sprayed into a water glass filled about one-third with pure water, the water poured off until a few drops of diluted gypsum are carried off, at which point the gypsum is saturated. The remainder is stirred slowly and slightly with a glass rod and poured on a clean glass plate held close under the water glass. The rotary kiln gypsum will form a smooth surface, whereas the boiled (kettle) gypsum will bulge in the center of the cake. Immediately after this operation the remainder in the water glass is evenly distributed over its bottom and side by swaying the glass; and setting it down; a correctly burned gypsum will remain uniformly distributed over the glass surface and without cracking; and after setting, the entire shell or larger parts may be taken up from the water glass; this shell may be up to 0.1 mm. in thickness and after drying it becomes suitably solid and elastic, which is impossible with gypsum of inferior grade. Then, when the gypsum sample has again acquired room temperature, it is removed from the glass disk, small pieces are taken from its edge and rubbed between the ends of two fingers. If it smears, the quality is not first class, for a good gypsum will always leave a minimum of particles. In the case of oven-burned gypsum, the paste may be poured from the water glass smooth as a mirror, and need not even be stirred with the glass rod, but the glass merely sways around, indicating that correctly burned, rapid-setting, or stucco gypsum saturates uniformly with water, whereas those of inferior quality saturate irregularly and must be stirred before the sample can be poured from the glass. If the oven-burned gypsum or refined gypsums are intended for dental purposes (to start to set in 5 to 8 min. then in a muffle oven of 24-hour burning period), the temperature, to be kept absolutely constant in spite of all practical difficulties, must be higher than for ceramic gypsum, which can to advantage remain longer in the oven, for in the ceramic or form gypsums the long pouring period and the consequent (1-hr.) hardening to great strengths is essential. The burning temperature must be tested out for each gypsum rock. S. finds these most suitable:

Gypsum rock	For dental gypsum (°F)	For form gypsum (°F)
Harz	356	320
Russia (Kasan)	338	297
Rumania	365	320
Italy	392	365

As mentioned, the oven-burned gypsum is characterized by a sudden hardening right after the termination of the setting period, whereas rotary kiln and boiler gypsum harden sluggishly. The refined gypsums burned in modern shaft kilns have the charac-

teristic of a long pouring period, being 10 min. or more in the case of form gypsum, perhaps due to the burning period of about 6 days, the uniformity of the gypsum being effected by a very gradually increasing temperature without cooling, due to the fact that the kiln is not cooled down and that a trained fireman can keep the temperature within a maximum admissible deviation of ±3°C or 5.4°F. Form gypsum thus prepared was tested in parallel with the Paris form gypsum of a roofing tile factory; after each of the two kinds (about 12 gypsum forms) had been made, being 2 upper and 10 lower forms, pressing was started $1^1/_2$ hrs. after each cast of the gypsum forms, with the result that the average output was 2160 pressed roofing tile for the former, whereas the Paris form gypsum brought it only to 1620 pressed roofing tile. By aid of these tests and under much practical experience and constant control, the quality of the gypsum may be improved. F.P.H.

Fused cements with a high alumina content. R. FERET. *Ann. ponts et chaussées*, Nov.-Dec. (1927); *Bldg. Sci. Abs.*, **1**, 207.—A comprehensive series of experiments has been carried out on binary and ternary systems of chemically pure SiO_2, Al_2O_3, and lime. The fused materials have been cooled quickly, by quenching, or gradually, then ground to a uniform fineness and tested for strength, soundness, and resistance to chemical attack. Contrary to experience with granulated slag, these products, if plunged into water while still fluid, give less favorable results than those cooled normally. Their setting time is shorter and their strength inferior. In general, the products fall into three classes: (1) those incapable of setting, (2) quick-setting cements of low strength, in some cases expanding or disintegrating in water after hardening, (3) slow-setting, high-strength products resistant to those salt solutions which are highly injurious to ordinary cements. A ternary diagram is given showing the zones occupied by the three classes mentioned, and details are presented in the form of a table. The diagram shows that the replacement of lime by silica, in a compound of fixed alumina content, results in a rapid decrease in strength. The proportion of alumina should lie between 45 and 70%; of lime, between 47 and 28%; and of silica, between 12 and 0%. These values hold only for chemically pure substances, the impurities present in commercial raw materials causing considerable modification. (*C.A.*)

PATENT

Cements. N. V. S. KNIBBS. Brit. 303,639, Feb. 27, 1929. A cement of the high alumina type is produced by subjecting a mixture of lime and bauxite or other highly aluminous material to the action of steam, preferably under pressure, to secure reaction between the raw materials, and then subjecting the resultant product to a higher temperature which is normally however below the melting point. The proportions may vary from one to two parts of lime to three parts of bauxite. The bauxite is ground and mixed with either quick or hydrated lime. The steam treatment when carried out at a pressure of 100 lbs. per sq. in. may be completed in one hour. The heat treatment may be between 1000 and 1400°C. With bauxite containing 50% alumina and 20% iron oxide four hours heating at 1100 to 1150°C is sufficient or two hours at 1150 to 1200°C.

Enamels

Enameling sheet steel. II. WALTER SCHULZ. *Ceram. Ind.*, **12** [4], 447–49 (1929).—All incoming raw materials should be weighed, a sample batch smelted and followed through the enamel shop to find any defects in advance before it may cause trouble in the regular run. Borax is influenced to a great extent by weather and storage conditions and should be watched. Storing too much soda ash causes it to form hard lumps which do not easily mix with other chemicals. Natural cryolite and a good grade of artificial cryolite have about the same analysis, but their effects and behavior in enamel are not identical. Feldspar is subject to the widest range of variations; an

enameler should have a reliable source which will always furnish the same quality. Organic and volatile matter is detrimental in clays but not harmful in materials which are subject to the heat of the smelting process. For Part I see *Ceram. Abs.*, **8** [4], 255 (1929). F.P.H.

Cleaning and grinding castings. ANON. *Iron Age*, **119** [26], 1886 (1927).—Tumbling barrels are used. A.J.M.

Proper fusing of enamel. F. W. MANKER. *Iron Age*, **120** [9], 531 (1927).—The plant of the Detroit-Michigan Stove Co., Detroit, Mich., is completely described. The enamel firing is accomplished by means of 9 gas-fired furnaces of the muffle type. Each furnace is 20 x 10 x 9 ft. Each furnace is heated by 8 burners firing under the muffle, which is of silicon carbide. This muffle is heated to incandescence and the furnace is heated by radiation from this. The enamels are fired on at temperatures varying from 1400 to 1600°F in from 3 to 5 min. Gas is supplied at 15 lb. pressure and inspirates the right amount of air for perfect combustion in patented venturi type proportioners. The temperatures are controlled and maintained by automatic pyrometer controls. Two track tables or double forks are supplied for loading and unloading. A.J.M.

Homogenizing frit. F. H. ZSCHACKE. *Sprechsaal*, **61** [17], 321–24; [18], 344–45; [19], 367–70; [20], 386–87 (1928).—A study of a series of commercially prepared glaze mixtures gave frits which exhibited inhomogeneities. A perfectly homogeneous frit was not found in any case. The reasons for these inhomogeneities may be traced to the following factors: deficient mixing, faulty weighing or measuring of the raw materials, influence of moisture present in the raw materials, variable specific gravity and particle size, influence of weight by volume and tendency to pulverize, and too short mixing periods. Suggestions for obtaining homogeneous frits are included. R.A.H.

Electric furnaces for enameling. HANS NATHUSIUS. *Keram. Rund.*, **35,** 124–26 (1927).—Electric resistance furnaces for enameling were first made with graphite and then with silicon carbide as the heating units but both types oxidized in time. Modern furnaces use an 80%Ni-20%Cr alloy as the resistor. To reduce current consumption the walls must be well insulated and the heating units so distributed that the temperature distribution through the furnace is uniform. Temperatures are usually controlled by regulators of the potentiometer type. The absence of fuel storage bunkers allows economy in space and ware losses are reduced since the fuel does not cause dust which may settle on the ware. Electric furnaces as observed in America for enameling bath tubs, watch dials, and signs are described in detail. H.I.

Some causes of sponginess on the upper surfaces of iron castings. T. BUTTERWORTH. *Iron and Steel Ind.*, **2** [2], 43–44 (1928).—Sponginess is caused by dirt accumulated by the hot metal from the mold sides, by slag formed through a reaction of the metal and the mold sand, by iron oxide resulting from a reaction between the metal and the water held in the mold sand, and by gas holes formed during solidification and originating in the solubility of O, N, CO, and H in the molten metal. The question of avoidance of these defects is discussed and a number of partial solutions pointed out. (*C.A.*)

The growth of cast iron. FRITZ WÜST AND OTTO LEIHENER. *Mitt. Kaiser-Wilhelm Inst. Eisenforsch. Düsseldorf*, **10,** 265–81 (1928).—Thirty-one papers on the growth of cast iron are reviewed. The growth of cast iron was observed after heating specimens for various periods in a neutral atmosphere at 600° and in superheated steam at 330°. Specimens of the following composition were heated in a neutral atmosphere: 2.49 to 3.90% total C, 1.70 to 3.17% graphitic C, 0.18 to 1.03% combined C, 0.50 to 2.82% Si, 0.39 to 1.42% Mn, 0.09 to 1.87% P, 0.03 to 0.153% S. Specimens of the following composition were heated in superheated steam: 2.45 to 3.86% total C, 1.74 to 3.29% graphitic

C, 0.19 to 0.91% combined C, 0.95 to 2.82% Si, 0.39 to 1.42% Mn, 0.09 to 1.87% P, 0.03 to 0.14% S. In each case specimens were selected representing three zones in the metal: (1) border, (2) between border and middle, and (3) middle. The growth in neutral atmosphere and in superheated steam within the three zones was investigated. A comparison was made of the growth of specimens normally prepared and specimens remelted in vacuum. The effect of preliminary heating in vacuum on growth in neutral atmosphere was also investigated. The data are summarized in six tables and 62 graphs. Micrographs illustrate the decomposition of cementite and the formation of graphite. It is concluded that: (1) the influence of chemical composition upon the growth of cast iron is obscured by other factors; (2) the growth in neutral atmosphere with the decomposition of cementite cannot be explained; (3) the finer the form of graphite the smaller is the amount of growth; (4) the material in the middle zone grows faster than that in the border zone; (5) the gas content of cast iron has an important influence on growth. No conclusion is given on growth in superheated steam. (*C.A.*)

BOOKS

Photomicrographs of iron and steel. EVERETT L. REED. John Wiley and Sons, 1929. 253 pp. $4. Reviewed in *Min. and Met.*, **10** [268], 223 (1929).—This book contains over 200 photomicrographs of iron and steel, some of which have been subjected to mechanical and thermal treatment according to standard practices, the heat treatments having generally been those recommended by the Society of Automotive Engineers. The collection is useful for reference purposes to producers and users of steel. F.P.H.

Bibliography of metallic corrosion. W. H. J. VERNON. Edward Arnold and Co., London. 1928, 341 pp. $8.40. Reviewed in *Min. and Met.*, **10** [268], 222 (1929).—This bibliography is the work of an investigator of corrosion and represents an enlargement of a bibliography prepared for the British Nonferrous Metals Research Assn. privately printed for its members. It comprises reference to papers on both ferrous, and nonferrous corrosion (including methods of protection), published up to the end of 1927. The publication is arranged chronologically under four main divisions: (1) types of corrosion and the factors influencing it; (2) the corroding medium; (3) the metal or article corroded; (4) protective methods. F.P.H.

PATENTS

Enameling composition. RUDOLPH WEIMER. U. S. 1,706,866, March 26, 1929. An enameling composition, consisting of a cold ground coating composition formed of ground silica, clay, lime, soda, boracic acid, broken pieces of glass and porcelain, and water for application in a cold condition.

Finishing surfaces of hollow metalware. ANDREW L. FABENS. U. S. 1,706,877, March 26, 1929. In apparatus of the character described, a closure member, means for clamping a hollow-ware article containing a mass of relatively hard balls against the closure member with the open end of the article against the closure member, means for rotating the closure member and the hollow-ware article clamped thereto and means for directing a stream of a cleansing liquid to the interior of the article.

White base for enamels and glazes. DEUTS. GASGLÜHLIGHT AUER, G.M.B.H. French 625,260, Nov. 29, 1926. White coatings are obtained by using bases comprising mixtures of titanium oxide with cerium oxide, or of either of these with white oxides of multivalent elements, preferably those of the 3rd, 4th, and 5th groups of the periodic system, *e.g.*, alumina, silica, stannic oxide, etc. (*B.C.A.*)

Enameling metals. ELECTRICAL RESEARCH PRODUCTS, INC. French 644,496, Nov. 25, 1927. Means are described for regulating the temperature of the enameling furnace to control the hardness of the enamel. (*C.A.*)

Glass

Glass furnace construction. A. ALISON. *Glass*, **6** [2], 52 (1929).—Friction losses in regenerators and flues are discussed. *Ibid.*, [3], 108 (1929).—A. discusses the evacuation of waste products, negative draft in checkers and uptakes, and frictional losses. For previous abstracts see *Ceram. Abs.*, **8** [5], 329 (1929). A.J.M.

Developments in glass furnaces and leers. S. R. SCHOLES. *Glass*, **6** [3], 103 (1929).—S. discusses the following changes in operation: increased temperature due to the introduction of automatic machines; improvements in regeneration, checker brick, recuperation, refractories, developments in throats, charging device, and annealing of glassware. A.J.M.

Corner and auxiliary firing in glass-melting furnaces. ERICH FELSNER. *Keram. Rund.*, **35**, 126–27 (1927).—Methods of auxiliary heating for pot furnaces are described. The purposes for which such methods are needed are (1) continuous heating of specific spots in the furnace during the working out, (2) periodic heating of furnace corners during the melting and working out, and (3) continuous heating of furnace corners or specific spots during the melting and working out. H.I.

Upkeep of glassmaking plant. C. W. BRETT. *Glass*, **6** [2], 54 (1929).—Two factors have contributed to the rapid changes in glass manufacture during the last half century: (1) chemical research and (2) the increasing employment of machinery and devices to increase output and facilitate handling. The introduction of mechanical devices has presented the problem of repair and maintenance. The three main causes for mechanical breakdown are (1) fracture through overloading or accident; (2) wear and tear due to friction, vibration, etc.; (3) injury, which includes distortion and out-of-alignment bending. Another source of trouble is the use of inferior or unsuitable material. By means of scientific welding any type of mechanical failure may be remedied and the unit restored to full power and capacity production. Scientific welding possesses 2 special advantages over every other known method of mechanical repair. It restores the member treated to 99% efficiency at less cost than replacement and it effects saving of time in restoring the unit to full service. In addition it is the only process which can be employed to make good the ravages of wear and tear, or to build up a component to its original or even larger dimensions. Another important feature is the fact that welding can be applied to the modern high-speed steel alloys. All welding work should be performed by a competent specialist. A.J.M.

Glass plant adjoins blast furnace and by-product coke works. ANON. *Iron Age*, **119** [11], 792 (1927).—This novel tieup is planned by the Oxelosunds Jarnwerksaktiebolog, Oxelosunds, Sweden. The glass plant, which will have 5 Fourcault units, with an annual capacity of 7500 T., will be fired by surplus coke-oven gas. A.J.M.

Plant efficiency. ANON. *Ceram. Ind.*, **12** [4], 424–34 (1929).—At the Owens Bottle Co., Fairmont, W. Va., the furnaces are fed by continuous feeders, and the storage hoppers are kept filled. There are no dog houses on the tanks, and the feeder mouth which is inserted in the tank is water cooled. When the tanks are shut down over Sunday, the feeder is removed and a water-cooled steel door is placed over the aperture. Each of the 6 tanks when carrying a capacity load of molten glass holds about 250 T. Producer gas and natural gas are used as fuel. The fuel is checked constantly for any variation which would affect temperature conditions in the furnaces. Pyrometric, draft and ammeter controls are used on the tanks and machines, together with automatic regulators which make the operation practically perfect, barring minor incidents which are uncontrollable. The temperature in the melting end of the tanks is in all cases 2600°F while the pot temperatures vary from 2000 to 2200°F. These temperatures in the pots are so finely regulated that a difference of ±5° is compensated for. This close regulation is necessary because of the variety of sizes and shapes produced at the plant,

each one of which requires a specific temperature for the best production. The machines are set to run at a certain speed, and a variation of a part of a second in some actuating device on the machine may prove a serious matter. An ammeter shows whether the machine is running properly, and this instrument is so delicately balanced that it will show as slight an effect on the machine as a bearing that is running dry. Each of these machines will turn out on an average of 500 to 800 gross of bottles a day, depending on the size and shape of the ware. F.P.H.

Owens Bottle Co. combines with Illinois Glass Co. ANON. *Ceram. Ind.*, **12** [4], 434–39 (1929). F.P.H.

Improvements in the manufacture of flat glass. II. H. K. HITCHCOCK. *Glass*, **6** [2], 66 (1929).—H. explains the old methods of making plate glass and the new continuous process. **III.** *Ibid.*, [3], 113 (1929).—Transferring of polishing tables, the turnover yard, stripping, dipping, cleaning, grading, and handling the abrasives are discussed. For Part I see *Ceram. Abs.*, **8** [5], 329 (1929). A.J.M.

The many-sidedness of glass. E. C. SULLIVAN. *Glass*, **6** [3], 96 (1929).—S. first pays tribute to the members of the research staff of the Corning Glass Works who have assisted him in his work. The development of certain special types of glass is discussed. A pie plate 9 in. in diameter of ordinary glass contracts 0.009 in. when cooled from the boiling point to the freezing point of water. A similar plate of low-expansion glass would contract 0.003 in. The difference between the 2 glasses in the amount of contraction is only 0.006 in., spread over 9 in. diameter, yet the ordinary glass plate heated to 100°C and plunged into ice water will crack while the low-expansion glass will stand a similar plunge from much higher temperatures. The expansion coefficient of glasses can be varied in a wide ratio by suitable changes in the chemical composition. Commercial glasses have linear expansivity ranging from three-millionths to eleven-millionths, these fractions representing the extent to which the length increases or decreases in heating or cooling 1°C. Where ordinary glass expands ten-millionths, metallic copper expands 17, iron 12, and platinum 9, this being also the figure for certain lead glasses which are readily sealed to platinum. For the Corning super-resistant glasses the value is about 3, and some of these glasses seal readily to porcelain, tungsten, and molybdenum, which have expansion coefficients of 4 to 5 on the same scale. It was thought at first that oven baking could be performed faster in metal baking dishes than in glass but it was found that the contrary was the case. Baking, then, is a process of radiation from the oven walls rather than conduction or convection. The surface of a metal dish throws back by reflection most of the heat rays striking it, whereas glass reflects not over 10%. Baking in metal is made more rapid by placing a glass plate under the metal dish. The slow movement of heat through the thick walls of glass makes cooling much slower. An outgrowth of the use of Pyrex beakers and flasks is the application of Pyrex tubing to ordinary laboratory glass-blowing. The low expansion of the tubing allows operations to be performed with less glass-blowing skill and less care. Low-expansion glasses are also used as reels for winding silk because the hardness of the glass prevents rapid wear. The chemical resistivity and low expansion are reasons for using these glasses in the field of high-tension electric insulation. Some of the Pyrex compositions are also utilized for radio insulation. S. discusses the physical properties of glass. Among unsolved problems are the following: (1) lack of knowledge of the chemical constitution and structure of glass; (2) need of material that is both homogeneous and unfluctuating in chemical composition, temperature, and physical properties; (3) better refractories than those now in common use; (4) excessive consumption of fuel caused by present practice of maintaining at or near the melting temperature too large a mass of glass. A.J.M.

Collapsing temperatures of laboratory glass tubing. A. W. LAUBENGAYER. *Glass*,

6 [3], 111 (1929).—Six kinds of glass were tested and each was subjected to 2 different tests. The glasses used were (1) an easily fusible soda-lime glass by Greiner and Friedrichs, (2) the "R" or resistance glass, made by the same firm, (3) Pyrex glass, (4) Jena combustion tubing, (5) Bohemian combustion tubing, and (6) Moncrieff combustion tubing. The tubes had a bore of 13 mm. and a wall thickness of 1.8 mm. The first test consisted in heating a piece of the tube, open at both ends, in an ordinary electric tube furnace of the resistance type. The temperature was quickly raised to 300°C and then raised uniformly at the rate of 3° per min. until the tube collapsed. The temperature was measured by means of a chromel-alumel thermocouple placed beside the tube in the furnace. For the second test the tube was sealed at one end, exhausted to 3-mm. pressure and heated as before. The results were:

	Collapsing temperature (°C)	
Glass	Open tube	Evacuated tube
Soft soda-lime	700	585
"R"	750	635
Pyrex	820	670
Jena	860	720
Bohemian	860	740
Moncrieff	820	770

The last glass devitrified rather readily. In order to avoid collapse a tube should not be heated higher than 50° below the temperature given in the table. A.J.M.

Automatic glass drilling machine. ANON. *Glass*, **6** [3], 112 (1929).—Most of the breakage encountered in drilling glass results from the fact that the pressure applied to the drill is too great. When drilling glass, it is customary to use an abrasive such as silicon-carbide powder. That this abrasive can be fed continuously forward to the point where cutting takes place, it is necessary to relieve the pressure on the drill periodically. When this is done by hand it is difficult to gage exactly the amount of pressure applied after each release, and this is probably the most general reason for breakage. In the new machine this periodic release of pressure is obtained by imparting a reciprocating movement to the drilling spindle by means of an eccentric suitably geared to the drill mechanism, while the actual pressure applied to the drilling spindle is obtained from an adjustable weight carried on a lever. This weight can be slid along the lever and secured in position so that when once fixed the pressure will be the same after each release. The drilling spindles are of hardened and ground steel, and run in lapped bearings, a ball thrust bearing being provided to take care of the upward thrust of the spindle. The power is obtained from a $^1/_6$-H.P. motor, the drive being by a round belt. Spindle speeds of 1800, 1200, and 600 r.p.m. are obtainable. The machine is capable of drilling holes between 4 and 80 mm. diameter. The machine will drill a 3-in. hole through 8-mm. plate glass in 12 min. This rate is greatly increased with softer glasses. A.J.M.

Drilling holes in glass. E. E. ERICSON. *Popular Sci. Monthly*, **114** [5], 98 (1929).—For drilling small holes in either window or plate glass, a triangular file makes an acceptable drill, using turpentine as a lubricant. For larger holes effective work can be done by using a brass tube with notches filed in the end thereof, and some abrasive such as silicon-carbide powder mixed with a little water. In the latter case it is well to have a device for holding the tube in place. E.J.V.

Minor constituents of glass. W. E. S. TURNER. *Chem. and Ind.*, **48T**, 65–67 (1929); **48**, 110–11 (1929); *Glass*, **6** [3], 111 (1929); for abstract see *Ceram. Abs.*, **8** [5], 328 (1929). H.H.S.

Excitation of luminescence in glass and fused silica vessels. W. L. LEMCKE. *Science*, **69**, 75–78 (1929).—When an exhausted glass tube containing a small quantity of Hg is held horizontally and given a reciprocating motion, static electricity is gener-

ated and light is produced. L. has made rotating vessels of glass and of fused silica of various shapes for the purpose of producing light mechanically. The effect of a minute quantity of a radioactive compound is to be investigated. H.H.S.

Glass sawed like wood. ANON. *Popular Sci. Monthly*, **114** [3], 61 (1929).—"Glass" is the creation of two English chemists, E. C. and E. J. Baly. Though having the appearance of ordinary glass, it can be cut or turned like wood. It is made from a chemical combination that produces a thick syrup, then hardens into the glasslike substance, which is nonbreakable and noninflammable. It is also believed to admit ultraviolet rays. E.J.V.

New wonders in glass. G. P. BAXTER, H. W. STARKEWEATHER, AND R. B. ELLESTAD. *Popular Sci. Monthly*, **114** [4], 49 (1929).—Glass is not as leakproof as it is commonly thought to be as a loss was noted in the case of helium gas sealed in a globe of fireproof glass for a year. Glass (or its substitutes) can now be made so tough that a bullet will glance off, so that it will bounce, bend, pour like water, and be sawed like wood. Austrian scientists have perfected a way to make it flexible. Glass wool, a fluffy stuff that looks and feels like silk, is ordinary glass spun into threads so fine that it would take 2800 of them to make a one-inch ribbon. E.J.V.

New use for glass. ANON. *Nat. Glass Budget*, **44** [48], 5 (1929).—Glass is being used in the hood of an automobile built by a German firm, in order that the mechanism may be seen working in every detail while the car is in motion. E.P.R.

Glass industry of Lancashire. ANON. *Glass*, **6** [2], 55 (1929).—Lancashire is the greatest glass-producing county in England. The total number of glass workers in the country in 1921 was 44,538; of these, 14,835 (almost one-third) were to be found in Lancashire. The numbers in the different glassmaking centers were then as follows: Lancashire, 14,835; West Riding of Yorkshire, 9139; greater London, 8025; Birmingham and District, 5437; northeast coast, 2961. In Manchester both fine tableware and industrial glass were produced; in St. Helens sheet glass, plate glass, and bottles were made; and in Liverpool, Preston, and Warrington were to be found the manufacture of bottles, electric bulbs, and table glassware, respectively. The old handicraft of stained glass window making was still in existence in Manchester. A.J.M.

Belgian glass industry. ANON. *Pottery Gaz.*, **54** [622], 620 (1929).—All branches of the Belgian glass industry were busy in January. Mirror glass had a reliable market. Orders exceeded production, which had to be increased. Selling has been assisted by the suppression of the export duty on mirror glass, but hindered rather by the new American duty. The Fourcault flat glass concerns now require three months for delivery. The prospects of the mechanically produced flat glass are so favorable that various concerns are proceeding to a larger production. A number of firms have decided to construct additional tanks. The bottle industry is rather more active. Mechanization in this industry increases, and completely automatic bottle-blowing machines have taken the place of the semi-automatic. E.J.V.

Hungarian glass industry. ANON. *Pottery Gaz.*, **54** [622], 620 (1929).—The Hungarian glass industry supplies about one-third of the country's requirements. Generally it is devoted to the production of household goods and common articles. Special products or artificial glass goods are either not made at all, or only in very small quantities. Flat glass, jugs, containers, bottles, etc., are the main products. E.J.V.

Russian glass industry. ANON. *Pottery Gaz.*, **54** [622], 629 (1929).—Russia is exporting lamp glass which competes successfully with the products of the French and Austrian factories. Recently a big order for glass was received from Egypt. At present it is producing 40 wagon loads of glass for Persia, Turkey, and China. Russia divests itself with difficulty of the old peasant methods in glass production. Examples are the slowness to adopt the use of tar as a fuel, and the lowering of the head of the glass-

smelting furnace. The Glass Trust has begun the production of a new variety of toughened glass on a large scale. It will be used mostly for glazing industrial establishments. E.J.V.

Italian glass market. ANON. *Pottery Gaz.*, **54** [622], 646 (1929).—Since January there has been a slight improvement in the number of orders received by the glass industry. Refractory goods factories are well occupied. Competition continues very keen both by home and foreign producers, the latter endeavoring to completely conquer the Italian glass market, selling goods not always of best quality at ridiculously low prices. The Czechoslovakian glassworks are importing into Italy glasses for liquors in coarse pressed glass. E.J.V.

Waste in Ukraine bottle factories. ANON. *Pottery Gaz.*, **54** [622], 646 (1929).—The production register of the bottle factories of the Ukraine Glass Trust makes an unsatisfactory showing. Cost price, breakage, and waste have risen sharply. At one factory of the Trust the cost of production exceeds the estimate by 220%(?) and the breakage and waste amount to 71.3% of the output. There does not appear to be any difference between hand- and machine-made in the result in waste. E.J.V.

Polish glass industry. ANON. *Pottery Gaz.*, **54** [622], 646–47 (1929).—The situation at the glass factories in 1928 was not uniform in all the branches of manufacture. The factories producing bottles were in a more satisfactory position, their production being increased by thousands of tons. The window glass factories had to limit their production toward the end of the season owing to the decline in activity in the building industry. However, as a result of the creation of the Verpol selling organization and the regulation of production, the factories were able to avoid over-production and losses. The situation was more difficult at the factories producing white table glass, fancy articles, and laboratory glass. A crisis was caused by the excessive production in 1928 which led to a fall in prices and selling difficulties, and rendered more acute by the very strong competition from Czechoslovakian products on the Polish market. Only the branch producing high-quality glass was in a satisfactory position. E.J.V.

Morocco as a market for glass. ANON. *Pottery Gaz.*, **54** [622], 660 (1929).—Morocco is a good field for glass goods, which find an improving market with the growing European population and the better standard of living. Table glasses without handles, wine and beer glasses (crystal or half crystal), and baccarat glasses sell well among Europeans and natives. The latter buy expensive glass goods quite readily, so that Bohemian glass goods, decorated, etc., find many buyers notwithstanding their high prices. The natives also buy colored and gilt tea glasses, which are delivered in cases containing 1000 pieces. Among the many kinds of tea, water, and coffee glasses, the natives show certain preferences. There is the "Sasbu," a tea glass in cone form, uncolored, half crystal, smooth or with long stripes, or more or less obvious ribs half-way up the glass. These forms are included in the term "Sasbu Msarrat." E.J.V.

Behavior of glasses toward saturated water vapor. FRITZ FRIEDRICKS. *Sprechsaal*, **61** [14], 261–63; [15], 282–85 (1928).—A review of the work of Förster and Hodkin, and Turner is given followed by a discussion of the four partial reactions occurring in connection with the conduct of glass toward saturated water vapor. These reactions are (1) hydrolysis of the glasses, (2) the solution of glass in water, (3) peptization of the silicic acid, and (4) mineralization of the glasses. F.'s present studies are on these four reactions, using the autoclave method of Förster in his work. Twenty-two chemical apparatus glasses were investigated and the data obtained are given in tables and curves. R.A.H.

Chemical action in annealing glass. GUSTAVE KEPPELER. *Sprechsaal*, **61** [16], 300–305 (1928).—K. points out the two following distinct actions in this process: (1) action in mass as a whole, (2) action in the surface. Data are presented based on these

considerations which show the effect with no annealing, compared to one and two annealings when the glasses are treated with different solutions. R.A.H.

Glasses colored by sulphur. H. HEINRICHS AND C. A. BECKER. *Sprechsaal*, **61** [21], 411–14 (1928).—A discussion on the use of metallic sulphides, such as those of aluminum, iron, cadmium, magnesium, nickel, and copper for the production of yellow tints and colors in glasses and the conditions under which these colors are best produced. R.A.H.

Glasses of greater ultra-violet transmissibility. A. RUTTENAUER. *Sprechsaal*, **61** [23], 453–55; [24], 449–50 (1928).—A summary of a discussion and study includes the following: (1) Since 1907 glasses which transmitted ultra-violet rays have been rather unstable and made only in the laboratory. The latest ultra-violet glasses are produced commercially and in most cases permit the passage of larger percentages of the waves under 300 mμ than the old Schott and Co.'s uviol glasses. (2) The physiological importance of the ultra-violet glasses lies in the fact that they may be used as window panes or as filters or casings when used in building up organic tissues and the prevention of diseases. (3) Only a quantitatively determined ultra-violet transmissibility of glasses permits the proper valuation of the glasses. (4) Quantitative determinations were made of the ultra-violet transmissibility of glasses used in therapeutic work. A simple test method is described. (5) The ultra-violet transmission of the glasses decreases with increasing temperature and is also decreased by intensive passage of the rays. R.A.H.

Orientation of organic compounds by cylindrical glass surfaces and surficial orientation of the glass. JEAN-J. TRILLAT. *Compt. rend.*, **188,** 555–56 (1929).—In the course of a study of the effect on the Debye-Scherrer X-ray diffraction patterns of the deposition of organic compounds on polished cylindrical glass surfaces, the X-ray pattern of the glass surface itself was studied. The pattern showed a broad, intense band parallel to the axis of the cylinder, indicating that the mi-cells or molecules of the glass had a preferred orientation, probably normal to the surface. Calculated from the position of the band, the intermolecular spacing was 3.3 Å. H.I.

Knox-O'Neill suction feed bottle machine. J. M. HAMMER. *Amer. Glass Rev.*, **48** [23], 15–18 (1929); for abstract see *Ceram. Abs.*, **8** [3], 178 (1929). E.P.R.

Paper milk bottle trial. ANON. *Nat. Glass Budget*, **44** [47], 10 (1929).—A firm in New York state is experimenting with a paper milk bottle that is to be given six months' trial. The paper container naturally can be used only on one trip, while there is practically no limit to the number of times that the glass milk jar can be used. In some sections the largest dairy operators get an average of twenty trips per bottle. This means that the cost of a glass milk jar to the dairy, per quart, is approximately one mill. E.P.R.

Opacification of lime-lead glass and alumina-lead glass. SUKEAKI SAKAI. *Bull. Mazda Res. Inst.*, **3,** 51–58 (1928).—On a lime-lead-soda glass (LF-5), and alumina-lead-soda glasses (AF-3 and AF-6) the opacification test was made by means of the following 4 methods of heating: (*a*) heat gradually to a definite temperature and keep at this temperature for some time; (*b*) heat rapidly up to this temperature and keep at this temperature for some time; (*c*) cool from the melt to a definite temperature; (*d*) cool once from the melt to a lower temperature and then gradually heat to a definite temperature. LF-5, containing less than 1.5% Al_2O_3, is more likely to opacify than AF-3 and AF-6 containing 3.4 and 2.4% Al_2O_3. LF-5 begins to become opaque at about 600° and becomes most so at 750 to 800°. AF-3 and AF-6 are very difficult to opacify; the crystal first formed vanishes again above 1000°. The difference between the results of the treatment according to (*c*) and (*d*) is not clear. In the treatment (*d*), those first cooled to room temperature and then kept at a definite higher temperature for a

few hours are more liable to become opaque. The boundary between the clear portion and the milky crystalline portion is clearly recognizable, the formation of a fissure taking place at the boundary by reason of the difference of expansion coefficient. The opacification begins at the portions which are in contact with the outside atmosphere or with some such substance as a refractory material, or with a small particle of stone which is present as an inclusion. (*C.A.*)

Determination and separation of the alkalis. A. THÜRMER. *Chem.-Ztg.*, **52**, 974–75 (1928).—Various methods for the determination of Na_2O and K_2O in glass are discussed, preference being given to the Berzelius method of decomposition rather than that of J. L. Smith. (*C.A.*)

Study of the coloring of glass. KITSUZO FUWA. *Jour. Mazda Res. Lab.*, **3**, 21–49 (1928).—(1) *Coloring with Mo:* $(NH_4)_6Mo_7O_{24}\cdot 4H_2O$ is used by F. Mo gives no special color to glass, but the glass containing Mo according to composition sometimes presents opalescence on reheating. Above certain limits Mo cannot enter into glass, the remainder either floating on the surface of the melt or sinking to the bottom. (2) *Coloration with W:* Na_2WO_4, WO_3, metallic W powder, Na_2WO_4 + oxidizing agents, and Na_2WO_4 + As_2O_3 are used; WO_3 and its salts give no special color to glass. Metallic W partly suspends in the glass to color the latter gray. When WO_3 and Na_2WO_4 are added, opalescent glass is formed. Above a certain quantity, W cannot enter into glass, the remainder floating on the surface or sinking to the bottom in the form of H_2O-soluble salt. Na_2WO_4 with an oxidizing agent or with As_2O_3 produces no special coloration. (3) *Coloration with U:* U is used for making yellow glass, and the recent observation that the glass absorbs ultra-violet rays opened a wide field for its application. Na uranate, $UO_2(OAc)_2$, Na uranate + an oxidizing agent, Na uranate + As_2O_3 were tested. The use of WO_2 or Na uranate causes no great difference with phosphorescence, but the luster is best with Na uranate. 1 to 2% UO_2 salt gives a greenish yellow color; with 5%, deep yellow or orange to brown color is produced in some glass, the coloration being different with the kinds of glasses. Glass containing Na uranate fluoresces in different degrees, K glass more strongly than Na glass. If the glass contains boric acid, it has a strong fluorescence. K-Mg glass and K-Zn-B-SiO_2 glasses have always a beautiful fluorescence. The addition of As_2O_3 to Na uranate has no influence. (*C.A.*)

Shrinkage of glass threads during heating. I. SAWAI AND O. MORISAWA. *Z. anorg. allgem. Chem.*, **173**, 361–72 (1928).—The behavior of threads of lead borate glass when heated under varying loads has been determined. With small loads of the order of 50 to 500 g./mm.^{2} the initial expansion is followed by a contraction beginning at 180 to 190° and ending at 395 to 360° according to the load. Then follows a small range during which no change in length takes place, and finally rapid expansion ensues, due to the great decrease in the viscosity as the softening point is approached. The shrinkage is shown to be due to release of the longitudinal strains in the thread produced in its formation by rapidly drawing it out from a molten mass of the glass. When the viscosity of the glass decreases sufficiently to make these strains greater than the sum of the load and the viscosity, shrinkage takes place. With loads of about 1 kg./mm.^{2} shrinkage occurs, but the length of the thread remains constant between 200 and 400°. With higher loads the load is greater than the sum of the viscosity and the internal stresses, therefore, no shrinkage takes place on heating. (*C.A.*)

BOOK

Czechoslovakian Glass Directory. ANON. *Nat. Glass Budget*, **44** [47], 7 (1929).—Published by Jos. F. Rimpler, Haida, Bohemia. Names and addresses of Czechoslovakian glassmakers are given. E.P.R.

PATENTS

Annealing glassware. VERGIL MULHOLLAND. U. S. 17,263, April 9, 1929. (Reissue.) A leer for annealing glassware comprising an elongated tunnel, means for moving

articles of glassware therethrough, a flue extending longitudinally beneath the tunnel from a point adjacent to the entrance end thereof to a point beyond that at which permanent strains will not be reintroduced into the glassware in the tunnel, means for passing a heated medium through the flue, and means disposed at intervals along the flue for controlling the temperatures along the flue and hence those in corresponding portions of the tunnel.

Weatherproof laminated glass. LOUIS BARTELSTONE. U. S. 1,705,631, March 19, 1929. A permanentized sheet of laminated glass comprising an intervening sheet of organic material and external panes of glass, the edges of the intervening sheet being spaced inwardly from those of the glass to form a narrow channel; a film of linseed oil and rosin covering the edge of the sheet and the inner surfaces of the protruding margins of the glass panes; and a wax filler for the residual channel.

Cleaning plate-glass grinding tables or cars. JAMES GREEN. U. S. 1,705,915, March 19, 1929. Apparatus for cleaning plaster from the edge of a moving surfacing table having a row of glass holding pegs projecting above the top of the table and through the plaster, comprising a device having a roller positioned so as to engage the plaster and pegs as the table moves beneath the device and means pressing the device downwardly with sufficient force to fracture the plaster and drive the pegs downward.

Colored or diffusing coating for incandescent lamps and similar articles. MARVIN PIPKIN. U. S. 1,706,182, March 19, 1929. (1) The method of producing diffusing or colored bulbs for electric incandescent lamps and similar articles which consists in etching a surface thereof, and then applying thereto a diffusing or coloring medium so as to produce a deposit of the finely divided medium in the depressions of the etched surface to serve without additional binding medium as the finished coating. (2) The method of producing diffusing or colored bulbs for electric incandescent lamps and similar articles which consists in introducing into a bulb which has been frosted by etching the inside surface thereof a quantity of finely divided dry diffusing or coloring material and causing at least a part thereof to be deposited in the depressions of the etched surface.

Automatic glass-washing device. KARL SCHMIDT. U. S. 1,706,189, March 19, 1929. In a glass-washing device, the combination with a water supply casing, a rotatably mounted turbine wheel, a brush and means whereby the pressing of the glass to be cleaned into position over the brush opens the water supply casing, of countershaft gearing operatively connecting the turbine wheel and brush, and means for guiding and injecting the water issuing from the turbine wheel into and over the glass.

Determining the level of glass in a furnace. AIMÉ MATHÉ. U. S. 1,706,857, March 26, 1929. An apparatus for the precise determination of the level of the molten glass in a tank furnace comprising a source of light at one side of the furnace, an observing instrument at the opposite side of the furnace, the furnace having a pair of openings, through one of which light from the source may pass thereinto, and through the other of which the image of the light source may be observed by the instrument as reflected by the top surface of the molten glass, means for varying the relative positions of the source of light and the instrument in accordance with the level of glass, and means for determining the amount of such variation, whereby accurately to determine the level of the glass in the furnace.

Sheet-glass cooler. JESSE W. WILDERMUTH. U. S. 1,707,242, April 2, 1929. In a combination with a sheet glass apparatus, a cooler comprising a plurality of separate cylindrical members arranged in parallel relationship, each member contacting with its adjacent members, and means connecting one end of each member with an end of one adjacent member, and the opposite end with the other adjacent member to form a tortuous passage for the flow of a cooling medium therethrough.

Delivery of viscous glass. OLIVER M. TUCKER AND WILLIAM A. REEVES. U. S.

1,708,037, April 9, 1929. Apparatus for delivering viscous glass from a furnace comprising a long, narrow spout having a flow channel formed to be wider at its intake end than elsewhere along its length, the flow channel having a discharge orifice, means for regulating the temperature of the glass as it leaves the furnace and passes into the relatively wide inlet of the spout and means for applying a confined flame burning under pressure to the walls of the orifice and to the glass in the orifice.

Delivery of viscous glass. OLIVER M. TUCKER AND WILLIAM A. REEVES. U. S. 1,708,069, April 9, 1929. The method of conditioning molten glass for delivery from a spout, which comprises passing the glass through a long, narrow insulated spout channel in a stream which gradually decreases in width from the inlet portion to the discharge portion of the spout, and subjecting the glass at the wide inlet, intermediate and narrow discharge portions of the channel to separate temperature-modifying mediums.

Making wire glass. HENRY F. CLARK. U. S. 1,708,662, April 9, 1929. (1) In the method of making wire glass, the steps consisting of passing a wire fabric upwardly through a guide and protector which initially projects above the level of a bath of glass, engaging the wire fabric above the bath, lowering the guide and protector sufficiently to give the glass access to the wire fabric, and continuing the feed by engaging successive portions of the wire fabric with the engaging means above the bath. (2) The method of making wire glass, which consists in drawing the central portion of a web of wire fabric through a bath of molten glass, while protecting the edge portions thereof from contact with the glass.

Vitreous composition. FRANZ SKAUPY. U. S. 1,708,743, April 9, 1929. A white enamel for incandescent lamps comprising by weight about 65 parts lead oxide, about 15 parts zinc oxide, about 20 parts boric anhydride, and about one-half part arsenic.

Apparatus for coloring glass inclosures. JOHN T. FAGAN. U. S. 1,708,788, April 9, 1929. In a machine of the class described, the combination of a holder comprising an apertured socket for receiving the neck of a bulb or similar article, a cup having an aperture in registry with the aperture in the socket, a support adapted to receive the holder, and means for simultaneously vibrating and rotating the support.

Glass manufacture. P. A. FAVRE. Brit. 304,664, March 20, 1929. Relates to the method of making tubing, described in Brit. 300,646 (see *Ceram. Abs.*, **8** [4], 266 (1929)) in which a glass cylinder with an axial bore is threaded on to a tubular former and its lower end is heated by gas flames. The glass melts and flows over the bulbous end of the former, and is drawn off by suitable drawing-devices. The present invention consists of a number of modifications of the apparatus described in the previous patent. The former may be made of refractory earth, and it may be surrounded by an oven consisting of a bottle-shaped casing which is heated by any suitable means. A number of cylinders may be threaded on the former, a new cylinder being added as the lowest one is consumed. Instead of a cylinder two half cylinders, or a bundle or rods, may be assembled around the former. The glass cylinders can be replaced by a refractory tube which surrounds the former and is filled with broken glass. Molten glass may also be poured into the top of the tube, the heating arrangements being modified so that the glass at the bottom of the tube has the necessary stiffness. In a modified construction, the former is inverted and is formed integral with a dished member. Molten glass is ladled into the member and is drawn upward over the bulbous enlargement, the draw being started by means of a bait ring.

Heavy Clay Products

Effect of cores in brick dies on power consumption. D. P. OGDEN. *Jour. Amer. Ceram. Soc.*, **12** [5], 351–55 (1929).—Recording watt-meter determinations of power,

moisture content, and production rates were secured on an individually motor driven auger machine for each of two standard brick dies, with and without cores. Variation in these factors was recorded. Use of cores causes a great increase in power consumption per thousand brick. Moisture content variation ranged from 17.7 to 20.1%.

Face brick industry adopts trade practice code. ANON. *Brick Clay Rec.*, **74** [7], 460–62 (1929).—A trade practice conference of the face brick industry, presided over by Federal Trade Commissioner W. E. Humphrey, was held at the U. S. Chamber of Commerce Building, Washington, D. C., March 14. The conference was held pursuant to resolutions adopted by the American Face Brick Assn. and the Face Brick Dealers' Assn. of America at their annual meetings at Hot Springs, Va., December, 1928. The 33 resolutions adopted by the dealers and manufacturers are listed. E.J.V.

Building codes. ANON. *Brick Clay Rec.*, **74** [8], 528–29 (1929).—The brick and tile industry's nation-wide market is threatened by building codes promoted by manufacturers of competitive materials. The code project is being fought by the brick and tile industry. Uniform building codes are not practicable, and it is not ethical to influence building codes. The danger to brick and tile is pointed out and strong vigilance is urged on the part of the clay products industry. E.J.V.

Brick withstands severe tests. ANON. *Clay-Worker*, **91** [4], 322 (1929).—Examples are cited of brick houses remaining undamaged after a cyclone in Columbus, Ga., had demolished frame houses between some of the brick homes. In St. Louis a fire destroyed a cinder block building so completely that there was scarcely a whole cinder block left but walls of brick buildings withstood the tremendous heat and remained standing. Both occurrences show the superiority of brick construction and serve as good sales propaganda. E.J.V.

Low cost of brick. ANON. *Brick Clay Rec.*, **74** [7], 474–76 (1929).—Following the lead of other brick manufacturers, the Des Moines Clay Co. proved, by simple comparative cost tests, that a brick house costs very little more than a frame house to build, and is changing Des Moines, Ia., to a city of brick construction. E.J.V.

A challenge to brick. PHILIP O. DEITSCH. *Clay-Worker*, **91** [4], 314–16(1929).—A paper by the Secretary-Manager of the Philadelphia district of the Brick Mfrs. Assn. outlining Philadelphia's better building program read at the 11th Annual Convention of Common Brick Mfrs. Assn. E.J.V.

Production of light weight aggregates. ANON. *Brick Clay Rec.*, **74** [8], 529 (1929).—Low-grade clays, shales, and shale rock when heated rapidly at about 2000°F, for a short period of time expand to $2^1/_2$ to 3 times their original volume. Material sintered in this fashion when subsequently crushed and used with a concrete aggregate yields concrete of the same or somewhat larger compressive strength and of only $^2/_3$ the weight of that made with ordinary rock and sand aggregate. The decrease in weight effects a great saving in the cost of structural steel for large buildings, bridges, etc. In view of the importance of this new industry as evidence by the number of inquiries concerning the deposits of clays and shales available for the manufacture of light-weight concrete aggregate, the Nonmetallic Minerals Expt. Sta., U. S. Bureau of Mines, in coöperation with the Rutgers Univ. Ceramic Dept. at New Brunswick, N. J., is planning to start a survey of such deposits, and a laboratory investigation of the fundamental factors involved in the manufacture of these aggregates. E.J.V.

Better clay machinery. ANON. *Brick Clay Rec.*, **74** [8], 534–40 (1929).—The clay industry developed slowly in a mechanical way until recent years, but it has awakened, and improvements have been made in the design and construction of clay machinery. The improved machines feature increased capacity, lower production costs, and better products. With the building of sturdier machines, with less wearing parts, better lubrication, use of bearings in consuming less power, the modern machine is

achieving its purpose in helping cut down the manufacturer's operating costs. Another big advantage is the reduction of repair costs. E.J.V.

Ontario clay products manufacturers amalgamate. ANON. *Can. Chem. Met.*, **13** [3], 36 (1929).—A new organization has been formed, under the name, The National Sewer Pipe Co., Ltd., comprising the following companies: The Hamilton & Toronto Sewer Pipe Co., Ltd., Hamilton; The Ontario Sewer Pipe & Clay Products, Ltd., Mimico; The Dominion Sewer Pipe & Clay Industries, Ltd., Swansea and Aldershot, and their selling organization, The Clay Products Agency, Ltd., Toronto. The head office of the new firm will be at the Metropolitan Bldg., Toronto. E.J.V.

Factory design and equipment. XXI. T. W. GARVE. *Clay-Worker*, **91** [3], 221–24 (1929).—Methods by which safety in a factory can be safeguarded are discussed. Fire protection and methods of making a plant sanitary, such as dust arresting, screening, and air separation are taken up. **XXII.** *Ibid.*, **91** [4], 309–13 (1929).—General plant arrangements are discussed and described, diagrams for several different layouts being given. For previous abstracts see *Ceram. Abs.*, **8** [4], 268 (1929). E.J.V.

Oil engine powered brick plant. ANON. *Clay-Worker*, **91** [3], 224 (1929).—In the Texas counties of Limestone, Navarro, and Ellis, are extensive deposits of blue and yellow shales of excellent quality for making dry-press brick. The Groesbeck-Standard Brick Co. makes dark red face and building brick from the yellow which overlies the blue shale deposits and which is somewhat less plentiful than the blue shale but which makes a darker colored and finer quality of brick. The plant is modern in every respect and has a capacity of 40,000 brick a day using the dry process. Power for the presses, mixers, dry pans, and other machinery is furnished by a 100 H.P. Primm oil engine and, to produce the small amount of steam needed in their process, they burn natural gas purchased at a reasonable rate since they are near a large Texas oil field. As the other brick plants of this section use fuel oil for steam production and for firing their kilns, the fact that the Groesbeck plant uses oil engine power and natural gas renders it unique among the plants of this locality and makes possible for it many economies in operation. The Primm engine does not require the services of a regular engineer but is looked after by the machinist in odd moments and it has furnished power for nine months at 28.4¢ per 1000 brick made, with less than $5.00 spent for repairs. E.J.V.

Public drains. GEORGE M. FRIES. *Clay-Worker*, **91** [3], 232–34 (1929).—An interesting tile underdrainage article by the field engineer of the Indiana Drain Tile Mfrs. Assn. E.J.V.

Brickmaking in New England. ANON. *Clay-Worker*, **91** [4], 317–20 (1929).—The plant of the New England Brick Co. at Cambridge, Mass., has been in operation since 1863 but has kept up with the progress of the times and is now a good modern plant. After this long period of operation, there is still enough clay in the pit to last for 50 years at the present rate of production of 800,000 brick per week the year round. The details of pit and plant equipment are given. Though new methods of manufacturing replace the old, there still remains a demand for the old product around which development has taken place. This is true in the brick industry in that there is still a demand for hand-made wood-fired water struck brick. One of the few plants devoted exclusively to this work is located at Gonic, N. H., and is owned by the New England Brick Co. of Boston. The production of hand-made brick at this plant amounted to 7,500,000 from May to October, 1928. Methods and equipment used in this plant are described. The Sponzo Brick Co., of Hartford, Conn., operated by the Sponzo brothers from April to October, has a maximum yearly output of about 4,000,000 bricks. The clay pit, plant, equipment, and methods used are discussed. E.J.V.

New Swedish invention for brickmaking. ANON. *Clay-Worker*, **91** [4], 346 (1929).—A revolution in brickmaking has been promised by two Swedish engineers,

who claim to have developed a "dry" method of manufacturing brick. The clay, before being used, is thoroughly dried at the point of production by heat or a vacuum, and is then pulverized. This product, which is known as "clay metal," can be transported easily to plants, and there again turned into a plastic mass simply by the addition of water. E.J.V.

100-story skyscrapers. ANON. *Popular Sci. Monthly*, **114** [5], 47 (1929).—A discussion of the new light weight building tile invented by Edward C. Kerth. See also *Ceram. Abs.*, **8** [4], 271 (1929). E.J.V.

House built of drain pipes. ANON. *Popular Sci. Monthly*, **114** [5], 60 (1929).—A "log house," in which the "logs" are formed by common red drainpipe tile, has been built in Kingsville, Ontario, Canada. Tile was chosen for the material because it provides dead-air space in the walls to protect the interior from cold in winter and heat in summer. A wooden framework, sheathed with boards in the usual manner, was first erected and the tile "logs" were laid in courses like brick veneer up the sides. At corners, the ends of the tiles overlap in criss-cross fashion, much as did logs in the cabins of pioneer days. Where the ends of the tiles are exposed, they are closed with cement colored to match, thus insuring dead-air space for insulation. The cost of the unusual house is said to have been moderate as compared with the cost of constructing a conventional type wood or brick home. E.J.V.

Packing in the brick and tile industry. HOFHERR. *Ber. deut. keram. Ges.*, **10** [1], 15–19 (1929).—Specifications covering the methods of packing and loading of brick and tile as required by the transportation agencies of Germany are described. F.P.H.

Miniature cement plant. ANON. *Cement, Mill, and Quarry*, **34** [3], 29, 48 (1929).—One of the feature exhibits of the Florida Road Builders first show in connection with the 6th annual Florida Good Roads conference, held in Jacksonville March 19 to 23, was a miniature of the Florida Portland Cement Co.'s plant. E.P.R.

Steel vs. cement. ANON. *Cement, Mill, and Quarry*, **34** [4], 36 (1929).—Despite the great vogue of cement road building fabricated structural steel has been coming out ahead in general totals. The tonnage of fabricated structural steel gained approximately 162% from 1913 to 1928, while shipments of Portland cement increased only 95%. E.P.R.

Lime as used in sand-lime brick. D. M. GRAY. *Cement, Mill, and Quarry*, **34** [4], 18–19 (1929).—There were formerly two methods of slaking lime. One known as hydrating consisted of putting the quick-lime in quenchers or boxes, adding sufficient water for hydration, and placing in the cylinders under the brick to complete the hydration by exposure to steam. The other method was the silo system in which the quick-lime, crushed or ground, was mixed with the dry sand and water added. This mix was left in the silo for two to five days to complete the hydration. It was mixed again and then used for brickmaking. The modern method of manufacturing hydrated lime depends upon addition of an exact amount of water to either lump, crushed, pebble, or pulverized lime with continuous agitation during the process of hydration. No other method produces a hydrate containing sufficient combined water to satisfy the demand of the calcium oxide present. If all calcium oxide is not hydrated the hydrate will be unsuitable, cause fracture, and ultimate breaking of the brick. Hydration of lime involves a chemical change, demanding, the presence of a definite quantity of lime and water, and an unlimited amount of agitation. Exacting supervision is necessary. Excess water is used. This excess of water is driven off by the heat generated in slaking. The quantity of water necessary varies widely dependent on a number of conditions: (1) the condition and form of the quick-lime, (2) the temperature of the water, and (3) the atmosphere. Too much water results in a damp or wet hydration, which is

difficult to handle. The two principal processes used by lime manufacturers in the making of hydrated lime are the Clyde and Kritzer systems. These are described. E.P.R.

Testing strength and fire resistance of materials. ANON. *Nat. Glass Budget*, **44** [47], 23 (1929).—The plants in which the tests to determine the resistance of combined fire and load were made required months to design and additional time to build. The tests occupied four years and were of the greatest value. E.P.R.

Brick industry. R. RIEKE. *Tonind. Ztg.*, **52**, 1459–61 (1928); *Refract. Jour.*, **4** [42], 184 (1929).—Numerous problems relating to brick firing are discussed and an appeal made for a more general application of scientific principles in the brick manufacturing industry. E.P.R.

Refractories

Comparative tests on monolithic refractory cements. H. N. CLARK. *Jour. Amer. Ceram. Soc.*, **12** [5], 330–35 (1929).—Samples of the leading monolithic cements on the market were subjected to laboratory tests. The three best cements as determined by the laboratory tests were then subjected to various tests under practical working conditions. All the laboratory and practical working tests up to date are discussed.

Magnesium and its compounds in 1927. J. M. HILL. Bur. Mines, *Mineral Resources of the U.S.*, Part II, pp. 167–79 (1928).—For many years magnesite and dolomite were the only commercial sources of magnesium products in the U.S. In 1927 a deposit of burcite (magnesium hydrate) of commercial size was discovered in Nev. In 1927 mines in the U.S. produced 121,490 short tons of crude magnesite, valued at $1,090,550, a decrease of 9% in both quantity and value as compared with 1926. Of the total output in 1927, 43,750 T. were produced in Calif. and 77,740 T. in Wash. Most of the production in Calif. was sold as caustic calcined magnesite, and most of that in Wash. as dead-burned. The pamphlet includes detailed data on imports, exports, the domestic and foreign industry, development and outlook, and production of various products. R.A.H.

Chromite in 1927. J. W. FURNESS. Bur. Mines, *Mineral Resources of the U.S.* Part II, pp. 309–21 (1927).—The world's production of chromite finds its way into 3 major channels, namely, metallurgical, refractory, and chemical. It has been estimated that the consumption in the U.S. in 1927 might be divided as follows: ferrochrome 46%, refractory 41%, and chemical 13%. The total imports of chromite into the U.S. in 1927 amounted to 222,360 long tons, approximately 56% of the world's production for that year. Practically the only chromite mined in the U.S. in 1927 was in Calif. and amounted to 5063 T. Detailed data for a period of years on imports of crude chromite are given. A discussion of the requirements of chromite for various uses together with production in foreign countries is included. R.A.H.

Checker brick for carburetors of water-gas machines. C. W. PARMELEE, A. E. R. WESTMAN, AND W. H. PFEIFFER. Univ. of Ill., Eng. Expt. Sta., *Bull.*, No. 179, 87 pp. (1928).—(1) *Scope:* The investigation of checker brick for carburetors of water-gas machines was initiated in 1924, because, under the conditions then existing, losses in the capacity of carbureted water-gas machines were being caused by the failure of the checkerwork in the carburetors, which were usually built of cheap, stiff-mud fireclay brick. The complete investigation comprised four smaller investigations, viz., a preliminary investigation, an investigation of fireclay brick, an investigation of special refractories and refractory coatings, and an investigation of heat-resisting alloys. The preliminary investigation revealed the main features of the problem and the difficulties involved in an adequate investigation of the situation. In the investigation of fireclay brick the physical and chemical properties of 23 brands were determined. The effects

of reducing gases, steam, and temperature fluctuations on fireclay brick, and the significance of black cores in used brick, were investigated. The service values of the different brands were determined by service tests in which samples of each brand were subjected to actual operating conditions in carburetors in Champaign and Chicago. From the data so obtained the relative importance of the different causes of failure, and the probability of making a radical improvement in the situation without recourse to materials other than fire clay were determined. In the investigation of special refractories and refractory coatings, service tests were made to find out whether any special materials which were ordinarily not used in carburetors gave promise of usefulness, and whether the life of checker brick could be increased by the application of coatings. The following materials were tested: silica brick, chrome brick, sillimanite brick, alundum-porcelain tubes, graphite blocks, fused-silica blocks and tubes, natural soapstone blocks, fired soapstone blocks, bonded silicon-carbide brick, a silicon-carbide coating, and two types of fireclay coatings. The investigation of heat-resisting alloys consisted principally of service tests in which alloy castings were subjected to the most severe conditions found in the carburetors in Champaign. Only readily available alloys were tested. (2) *Data:* Thirty-two tables of data gave practically complete information regarding the properties of the materials tested and the outcome of the tests. The number of specimens tested and the probable errors of most of the values are given. Twenty-three figures show the apparatus used, construction of the carburetors, condition of typical used brick, relations between service value and laboratory test results, temperature fluctuations in service, and the significance of the laboratory test data. (3) *Conclusions:* (*a*) *Fireclay bricks:* (1) With some grades of oil (topped crudes, fuel oil, etc.) the deposition of an asphaltlike material in the carburetors, and not the failure of the checker brick, was the primary cause of shut-downs. (2) Under the operating conditions investigated, fireclay brick, as a class, was found to be unsuited for use in the top courses of carburetors, although satisfactory in the lower courses. (3) The major cause of failure of fireclay checker brick was cracking, due largely to the quenching action of the oil. (4) Surface deterioration due to attack by slag and coke breeze was a minor cause of failure. (5) The deposition of carbon in the pores of the checker brick due to the catalytic action of iron impurities, the presence of steam in high concentrations, permanent contraction and expansion, and the formation of black cores were found to be relatively unimportant. (6) Each method of manufacture had advantages and disadvantages. The tendency to use stiff-mud brick made from plastic clay exclusively was due to considerations which were of little importance. The use of semiflint clay, or the addition of grog or flint clay, improved the properties of stiff-mud brick. Dry-press and semidry-press brick could be used more extensively. (7) No relation between the chemical composition and the service value was found. Even the iron content was unimportant. (8) Of the brands examined, the higher priced brands were liable, more often than not, to give poorer service. Increases in price caused by the introduction of flint clay or grog into stiff-mud brick appeared to be justified by the increased service rendered. (9) There was little reason for supposing that the efficiencies of different types of fireclay brick were significantly different. (10) The situation was such, that the formulation of adequate specifications was almost impossible, and would result in no pronounced increase in the service. This investigation did not justify a number of specifications which had been proposed, with the exception of specifications of dimensions and resistance to thermal shock. (11) The coefficients of texture and stoutness can be used in predicting surface deterioration and breakage in handling, respectively. Body deterioration can be predicted very roughly from a knowledge of raw materials and method of manufacture, with more certainty when the permeability is known, and with the greatest certainty by means of the thermal shock test developed as part of this

investigation. Discrimination between brands whose service values do not differ greatly, can be accomplished best by accurate, comparative service tests. (*b*) *Special refractories and refractory coatings:* (12) Of a number of special refractories which were tested only bonded soapstone and bonded silicon-carbide brick gave promise of usefulness. Service tests of bonded silicon-carbide brick showed that they were superior to fireclay brick especially in resisting surface deterioration, and that a composite checkerwork in which such bricks were used in the three upper courses could be expected to last twice as long as a fireclay checkerwork, and might be used economically in some carburetors. (13) Refractory coatings decreased the service value of bricks having a low coefficient of texture, but increased the service value of more open-textured bricks. This increase was not sufficient, ordinarily, to justify the cost of coating. (*c*) *Heat-resisting alloys:* (14) The life of some heat-resisting alloy castings in the top courses of the Champaign carburetors was more than 15 times and might be 20 to 30 times that of fireclay brick, that there was no reason for supposing them less efficient than fireclay brick, and that the only modification in operating procedure occasioned by their use was the necessity of avoiding excessive temperatures. (15) A composite checkerwork consisting of 12 courses of fireclay brick, 3 courses of bonded silicon-carbide brick, and 2 courses of heat-resisting alloy castings in the form of rails, would cost about 19 times as much as 2 fireclay checkerwork, could be expected to last about 15 times as long, and would result in an ultimate saving due to increased capacity, lower labor charges, and increased certainty of operation except in carburetors where slag-carbon deposition was very excessive or where extremely high temperatures would be encountered. (4) *Appendix:* A statistical interpretation of the data and a bibliography are given. A.E.R.W.

Thermal expansion of fireclay brick. A. E. R. WESTMAN. Univ. of Ill., Eng. Expt. Sta., *Bull.*, No. 181, 27 pp. (1928).—(1) *Scope:* The thermal expansion curves in the temperature range 25 to 950°C of twenty brands of fireclay brick were determined by means of an apparatus developed for the purpose. The brands covered a wide range of physical and chemical properties. Mineralogic composition was estimated from chemical analyses and petrographic measurements. The expansion curves were classified on the basis of the presence or absence of certain characteristic inflections in the curves. (2) *Data:* A tabular summary of previous investigations is given. For the twenty brands of brick the following data are reported: plant location, method of manufacture, and raw material; pyrometric cone equivalent, absorption, porosity, and apparent specific gravity; thermal expansion curves between 25 and 950°C and a mean curve for 17 fire clays; volume percentages of cristobalite, quartz, and free silica calculated from thermal expansion data, and of quartz, calculated from petrographic data; weight percentages of free silica calculated from thermal expansion data and chemical analysis, and the possible weight percentage of cristobalite resulting from mullite formation. (3) *Conclusions:* (1) Within the experimental error, the volume percentages of free quartz calculated from the petrographic data obtained by the powder-immersion method were either equal to or less than the volume percentages of free silica calculated from the thermal expansion data, and approximately equal to the volume percentages of free quartz calculated from chemical analyses. (2) With a few exceptions, calculations based on the chemical analyses indicated a free silica content high enough to account for the inflections in the thermal expansion curves. (3) With the exception of possibly 2 of the 20 brands investigated, it was not necessary to postulate the presence of cristobalite set free as a result of the decomposition of kaolinite and subsequent formation of mullite in order to account for the thermal expansion data. (4) For at least 18 of the 20 brands investigated, the data obtained from thermal expansion measurements, petrographic examination by the powder immersion method, and chemical analysis were in reasonably quantitative agreement with the assumption that the

lower inflections in the thermal expansion curves were due to the inversion of cristobalite and the upper inflections to the inversion of quartz, the cristobalite and quartz being originally present in the raw materials as uncombined silica. It could reasonably be expected, therefore, that with more accurate methods for determining percentage expansions due to inversions and more reliable factors for calculating percentages of cristobalite and quartz from such data, useful analyses of fireclay bricks could be made.

A.E.R.W.

Testing refractories. J. SPOTTS MCDOWELL. Amer. Refract. Inst., *Tech. Bull.*, No. 28.—The testing of refractories to determine their utility in service is complicated by the facts that they are used at high temperatures, and that their properties at these temperatures are not the same as in the cold condition. Resistance of refractories to abrasion and other destructive influences, and their ability to carry loads, decrease as they become hotter. Chemical attack by slags takes place solely at high temperatures. Since these things are true, tests which are to be correlated with service should generally be run on brick which are highly heated. Since interpretation of the results is difficult, great familiarity with the tests is necessary in using the laboratory data, else they may prove misleading. The Refractories Utilities Chart indicates major factors which affect the life of refractories, with the service conditions and the properties of refractories related to each. For example, the conditions of furnace design and operation related to abrasion of refractory linings are the character of the joints, the speed, pressure, area, hardness and angle of the abrading material, and the velocity, percentage and nature of solids in the furnace gases. The properties of the brick which influence the amount of abrasion are hardness, tenacity and toughness of the bond, size and shape of the grains, and density and strength. A thorough analysis of abrasive action is a very complicated matter. The same thing is true also of slagging, spalling and melting. None of these are functions of a single variable. In every case there are a number of independent variable factors, with an even larger number of dependent variable factors, which interact in a manner defying accurate analysis. *E.g.*, it is difficult, if not impossible, to determine precisely the effect of the hardness of a refractory upon its resistance to abrasion in service, because of the many other factors involved, and because the hardness itself changes in undetermined degree with changes in temperature. In the standard reheating test the brick are heated to approximately 2550°F, and the resulting changes in length determined. Since it has long been known that, at certain temperatures, most clays will expand through overfiring, appreciable expansion in the test has been regarded as due to overfiring, while excessive shrinkage has been attributed to underfiring. The second assumption is doubtless correct in most cases. Brick made of certain clays of very good quality will increase in length upon rapid heating, due to a phenomenon known as "secondary expansion," which is not overfiring in the common meaning of the term. One of the earliest slag tests used was that of a slag in a pocket in a brick, the brick heated to a definite temperature and the area of slag penetration noted. With much to commend in it the test is open to the criticism that it is little more than a measure of slag permeability. It does not include the effects of chemical action. Another slag resistance test consists of pulverizing the brick, mixing it with a definite quantity of finely divided slag, and determining the pyrometric cone equivalent of the mixture. This test is a measure of chemical action, but at temperatures which may not be comparable with service, moreover, it does not take into consideration the texture of the brick. Blowing finely ground slag into a small furnace tests the penetrability of the slag and degree of chemical attack. For control work the pyrometric cone equivalent (P.C.E.) is especially good. Determinations can be carried back to the raw material and followed through to the green brick mixture, and may be again applied to the finished product if desired. Chemical analysis is also good

and usually does not need to be carried out on an elaborate scale because each manufacturer usually knows what impurities are most likely to give trouble and these only need be determined in routine testing. The load test is likewise of value in control work, as brick made of a given clay by a given process, and fired in a definite way, will have a fairly definite shrinkage. The best methods of control, in any particular case, will depend upon the character of the product, and the objects to be attained. Control tests are not used to as great an extent as their importance merits. The manufacturers of brick could use these tests, far more than they do, with advantage both to themselves and to their customers. One disadvantage of much control work is the length of time which may elapse between the time of taking the samples and sending them to the laboratory, and getting the results. Some loss of time is, of course, unavoidable. It can be decreased by giving the laboratory instructions to report by wire on any samples which do not meet a certain standard. F.P.H.

Packing in the refractory industry. A. HAHN. *Ber. deut. keram. Ges.*, **10** [1], 11–15 (1929).—Specifications covering the methods of packing and loading of the raw and finished products of the refractory industry required by the transportation agencies of Germany are described. F.P.H.

Plant control in the German refractories industry. H. KNUTH. *Ber. deut. keram. Ges.*, **10** [1], 25–43 (1929).—A questionnaire was sent to various refractory manufacturers of Germany requesting information on the methods used to control the quality of their products. The replies showed that 90% of the manufacturers were using some form of plant control. Methods used in sampling clay, quartzite, sand, grog, and the finished products are described. The following tests are carried out on clays: (1) P.C.E. value, (2) sedimentation analysis, and (3) softening behavior. One firm determines the alumina content, density and refractoriness of the grog used in its products. The quartzite is tested for refractoriness. It is also investigated with regard to its transition velocity and the microscope is used for this investigation. The quartzite is fired 2 hrs. at 1450°C and another sample for the same time at 1500°C and the samples are examined for tridymite and cristobalite. Rapid methods of chemical analysis of raw materials are in use in most of the plants. The following tests were made: *clay bodies:* water content, grain size distribution, refractoriness, alumina and iron constants, and shrinkage; *silica bodies:* refractoriness, water content, lime content, and grain size distribution; *refractory cements:* refractoriness, sintering point, bond content, and grain size; *finished clay refractories:* P.C.E. determination, chemical analysis, porosity, resistance to temperature changes, resistance to slag action, and thermal expansion behavior; *finished silica refractories:* density, porosity, chemical composition, thermal expansion behavior, microstructure. F.P.H.

Diatomaceous earth. ELLIOTT S. HASTINGS. *Rock Prod.*, **32** [6], 50–54 (1929).—The term diatomaceous earth, as generally accepted, is applied to the siliceous remains of Diatomaceae, a species of minute, flowerless aquatic plants of the order Algae, and more accurately defines and describes the material than other terms now in use, *i.e.* kieselguhr, infusorial earth, diatomite, desmid earth, moler, bergmehl, tripolite, polirschiefer, celite, and others that have acquired significance through their use as trade names of local products. While the material has an almost universal distribution over the surface of the earth, relatively few of the deposits are of proper location for transportation, or are of sufficient size and purity to be of value for commercial exploitation. The most important deposits are found in the countries of North, Central, and South America, New Zealand, Barbados Islands, Scotland, Africa, Germany, Canada, Nova Scotia, and Ireland. Diatomaceous earths now in commercial use are of widely varying chemical composition. According to Goodwin, the limits of variation for a commercial material are silica 56.0 to 95.0%; iron and alumina oxides 8.0 to 0.2%;

lime and magnesia 7.0 to 0.1%; potassium, sodium oxides 5.0 to 0.0%; water, organic matter 15.0 to 4.0%. Few, if any of the deposits now being exploited commercially, fail to meet the above requirements, so that the relative superiority of a material for general use is determined mainly by the structure of the material and its physical characteristics. Since the general physical and chemical characteristics which make diatomaceous earth of great industrial importance have been discussed by authorities, the distinguishing physical characteristics are those of very light weight as compared to other sedimentary materials, great porosity with resultant high absorptive power, larger surface areas in comparison to average particle diameters, and low compressive strength. The outstanding chemical characteristics are the siliceous, inorganic nature of the material, its solubility in alkaline solutions, and nonsolubility in acid or neutral solutions, with the exception of hydrofluoric acid. To meet the commercial requirements, diatomaceous earth is supplied in the form of natural or calcined blocks, cut to size and shape desired; in powder form either crude or calcined, graded as to size, color, and relative freedom from impurities, depending upon the application of the material. Certain limitations are imposed upon the use of diatomaceous earth as a refractory material by reason of its low mechanical strength. In applications where strength comparable to that of the average firebrick is required, a mixture of diatomaceous earth and clay can be made, but this mixture is made at the expense of the full insulative properties of the diatomaceous earth. When properly adjusted to the insulative conditions and requirements there are few, if any, materials of equal value. In some special cases a vacuum was found to be its only superior. F.P.H.

Magnesite or dolomite for basic bottoms. MICHAEL KARNAOUKHOV. *Blast Fur. Steel Plant*, **17** [4], 545–47 (1929).—For the majority of plants the use of magnesite in making up and repairing hearths is preferable. The method of making a magnesite hearth is as follows: After the complete heating of the furnace, *i.e.*, when the normal heat regime has been established and the layer of magnesite brick has become hot enough, the pieces of basic slag should be scattered on top of this layer and melted down, impregnating the upper and partially the under layers of magnesite brick and the joints between them. The magnesite powder, scattered between the magnesite brick, sinters with the liquid slag and a durable joint is formed. This preliminary impregnation of magnesite brick by the basic open-hearth slag must be worked until the molten slag remains on the bottom as a pool near the tapping hole which is closed by means of magnesite powder. The impregnation of the brick must be worked very carefully and evenly over the whole surface of the hearth. Under these conditions the upper layers of magnesite powder will be durable and the expense of magnesite powder for repairs of the hearth during the work of the furnace will be low. For making the bottom a proper proportion of magnesite powder and basic slag is necessary to sinter the magnesite. Each layer of magnesite should contain a sufficient quantity of basic slag before its saturation by sintering. This latter after melting goes into the unsaturated brick and thus the magnesite powder remains dry and is not sintered. F.P.H.

French refractory hydraulic cement. J. ARNOULD. *Rock Prod.*, **32** [6], 57–59 (1929).—By using the formula which was developed so many years ago by Sainte-Claire-Deville, A. was able finally to make a hydraulic cement which, while it cannot be considered as absolutely refractory, nevertheless will withstand high temperatures without deterioration. This cement is a mixture of aluminous cement and bauxite made under certain conditions. The bauxite must first be calcined at a temperature which is above the temperature of the transformation of alumina, that is above 1070°C. The calcining process is carried out in vertical kilns of the lime kiln type. At a temperature of 500°C an endothermic reaction first takes place, which results in the removal of the water. Then from 1000 to 1070°C the reaction is exothermic and irreversible. The

alumina is really polymerized. The calcined bauxite is ground and screened wherever this is necessary before being mixed with the aluminous cement. The granular condition of the bauxite plays an important rôle in the future resistance of cement to the action of high temperatures, as well as in the setting of cement. The size of the granules of the bauxite may be varied in accordance with the uses for the finished material. It is in fact possible to attain a fineness which is comparable with that of cement itself by properly carrying out the grinding process. The mixture of *ciment fondu* and the bauxite should be made as perfect as possible, so that one grain or particle of the cement is followed by one of the bauxite. This entails considerable care in the operation of the mixing apparatus. This mixture has given very interesting and important results. In the first place it is really a good grade of hydraulic cement, which when admixed with 22 to 30% of water can be made to flow in suitable conduits, can be molded into various shapes, will set well and afterward harden. It sets slowly and hardens rapidly permitting the worker to mold it into shape without any hurry. The setting of the cement begins at the end of an hour and a half and is finished at the end of 4 to 6 hrs. The hardening of the cement proceeds very rapidly and at the end of a 24-hr. period it is possible under certain conditions to remove the mold facings. The resistance of the cement to compression is 145 kilos per sq. cm. at the end of 3 days (2000 lbs. per sq. in.). Its resistance to tension at the end of the same period of time is 21 kilos per sq. cm. (about 300 lbs. per sq. in.). In making a concrete with this cement it is advisable to employ old refractory brick, which, having been heated many times, have lost all shrinkage as aggregate. The refractory fragments are crushed in such a manner that the largest lumps do not exceed the size of a hazel nut or almond (about $^3/_4$-in. diameter). Care must always be taken to remove the dust after crushing, for this dust has the effect of preventing the setting of the cement under some conditions. The dust is removed by screening or by washing with a copious flow of water. When these cements are employed in the form of concretes, there are many uses which can be found for them; *e.g.*, they may be employed in the construction of furnaces and in the fabrication of specially designed pieces of intricate profile, which are difficult to secure under ordinary conditions. The cements may thus be employed in the building of chimneys, of baffles, of combustion chambers in producers, for lining the tubes in boilers, and for the flues in recuperative furnaces. In this case the parts are molded under pressure. The cements may also be employed in molding all sorts of parts, such as hearths of all dimensions and sizes, which are furnished with external supports of various kinds, and vaulted arch work.

F.P.H.

New light-weight insulating fire brick. M. IVAR SETTERBERG. *Brick Clay Rec.*, **74** [7], 465 (1929). *Refract. Jour.*, **4** [42], 163 (1929).—A new fire brick based on the same principle as the so-called gas-concrete, only one-half as heavy as ordinary fire brick but with three times greater insulation properties, porousness, resistance to high temperatures, and great mechanical solidity, making it very suitable for high-temperature furnaces, has been developed. Refractory materials are ground very finely and mixed with water to form a plastic paste, to which are added materials that develop gas when mixed with water, and the paste is then allowed to ferment. It is then made into brick, which are dried and fired at about 1300°C. The pores formed due to the development of the gas are made permanent by special methods. In firing, the brick acquire the necessary mechanical solidity and a structure resembling that of pumice stone, but are superior to natural porous minerals in fireproofness owing to the absence of any large quantities of easily fusible silicates. The brick do not melt below 1700°C. The new brick are at present being produced in Stockholm and Bromoella.

E.J.V.

Sillimanite. FRANK H. RIDDLE. *Can. Chem. Met.*, **13** [3], 27–28 (1929).—The

chemical composition of sillimanite and the history of its development are dealt with. The effect of the use of sillimanite in porcelain and in refractories is discussed. In Germany cyanite is being used instead of sillimanite in chemical stoneware. A practical demonstration of the indestructibility of sillimanite ware is given. E.J.V.

Spalling in oil-fired furnaces. ANON. *Clay-Worker*, **91** [3], 253 (1929).—There is more spalling of refractories in furnaces where the boilers are fired with oil than where coal is used. Slagging is a more common trouble with coal-fired furnaces. There is very little slagging in oil-fired furnaces because the ash content of fuel oil is less than 0.1%, whereas the ash content of coal may be from 8 to 18%. So far, however, there has been no clear explanation of the very common breaking up of the refractories in the furnace walls by spalling. It is thought that the trouble may be partly due to certain chemical actions set up in connection with the use of oil fuel. E.J.V.

Chemical examination of refractory materials. II. H. J. VAN ROYEN. *Arch. f. Eisenhüttenwesen*, **2**, 371–73 (1928); *Refract. Jour.*, **4** [42], 185 (1929).—Methods are described for the chemical analysis of dolomite, magnesite, sinter dolomite, sinter magnesite, and magnesite bricks. These methods include the estimation of silica, iron, alumina, lime, magnesia, and manganese. The results of the analysis of the materials are recorded in tables. E.P.R.

Uses for magnesite. ANON. *Cement, Mill, and Quarry*, **34** [3], 26 (1929).—Magnesite is known to science as carbonate of magnesium, and is produced in the U.S. mainly in Calif. and Wash. The uses for this mineral are: refractory brick, shapes, crucibles, and furnace hearths, for which both dead-burned magnesite and dead-burned dolomite are used; for medicinal and toilet preparations, as an absorbent in the manufacture of dynamite, fused magnesia for insulation at exceedingly high temperatures, and an adulterant of paint. E.P.R.

Development of aluminum deposits. ANON. *Cement, Mill, and Quarry*, **34** [3], 68 (1929).—International Silica Corp. is constructing a plant and installing machinery for the development of large aluminum deposits at Edgewood, two miles east of Salem, Va. This corporation controls the McAdoo patents and Johnson process for extracting aluminum from shale found in that locality. E.P.R.

Hartmann spiral brick. J. THORNBLAD AND W. B. MITCHELL. *Jour. West Scot. Iron Steel Inst.*, **36**, 28–34 (1928–29); *Refract. Jour.*, **4** [42], 185 (1929).—Hartmann spiral brick for hot-blast stoves are discussed with the savings effected by their use. The spiral brick in conjunction with their bearer brick can be placed on top of existing checker brickwork, but in the case of new stoves, the spiral brick packing can be built up right from the bottom of the stove with a consequently much reduced over-all height of such stoves. Tests have proven that a stove with an over-all height of 55 ft. and fitted with spiral brick alone is as efficient as a 95 ft. stove of the same diameter, fitted with the ordinary checker brickwork. Spiral brick are in use in a number of plants in this country, and the results obtained by their use at the Corby plant of Lloyds Ironstone Co. are given. E.P.R.

Brick crucible furnaces. MAY. *Mech. World and Eng. Rec.*, pp. 54–55 (1929); *Refract. Jour.*, **4** [42], 184 (1929).—An illustrated account is given of a modern type of furnace. It is advocated that all parts in actual contact with the fire should be of fire brick set with fire clay or finely ground ganister. The joints should be thin and the surface even and smooth. E.P.R.

Progress in refractory materials. A. B. SEARLE. *Metal Ind.*, Jan. 18, p. 71 (1929); *Refract. Jour.*, **4** [42], 183 (1929).—Reference is made to the general progress in the refractory materials used in the heat treatment of zinc, lead, copper, brass, bronze, tin, manganese, aluminium, antimony, nickel, and the precious metals. The main causes

of disintegration are discussed together with the application of refractory materials in muffle furnaces. E.P.R.

Refractories in the gas industry. E. W. SMITH AND H. M. SPIERS. *Refract. Jour.*, **4** [42], 193 (1929).—The refractories used in the gas industry are mainly silica, fire clay, and siliceous brick. Silica brick enable high temperatures to be maintained in the combustion chambers, and thereby higher gas yields per ton of coal and increased throughput of the carbonizing plant. Use of fire brick is confined chiefly to the cooler portions of the settings and to the producers. The composition and raw materials of the brick are considered. The requirements to be fulfilled are considered in detail under the headings (1) constancy of volume, (2) spalling, (3) refractoriness under load, (4) chemical stability, and (5) thermal conductivity. Physical properties of silica and their bearing on the manufacture and use of silica brick are described. Crystalline silica can exist in several forms, each of which is characterized by a different thermal behavior; this necessitates the use of well-fired brick in order that the brick will withstand the severe conditions to which they are exposed. The differences in the thermal expansion of the various types of brick used in gas-making plants are shown to be sufficiently wide to render necessary an accurate knowledge of this property in order that sound settings might be constructed. The properties of the jointing cements are described and the factors involved in the choice of a suitable cement. E.P.R.

Silica brick. B. M. LARSEN. *Refract. Jour.*, **4** [42], 183–84 (1929); for abstract see *Ceram. Abs.*, **7** [9], 619 (1928). E.P.R.

Refractories researches. Dept. of Scientific and Industrial Research. *Refract. Jour.*, **4** [42], 184 (1929).—Investigations have been carried out on the general processes employed in the manufacture of refractory products of all types and also into problems connected with the industrial uses of refractories. On the subject of the firing of refractories, attention has been drawn to: (1) thermal efficiencies of the various kilns now in use; (2) changes occurring in fire clay and silica goods at increasing stages of heat treatment; (3) effect of kiln atmosphere, rate of rise of temperature, etc., on these changes. Effects of different atmospheres on refractories at high temperatures have been studied and the results are important both in the manufacture and industrial usage of refractory products. Clay-bonded silica brick are not so liable to spall as are the lime-bonded silica brick. The effects of the crystalline composition of silica refractories on strength at high temperatures have been elucidated. Two reports of interest to different industrial groups have been issued, one on the insulation of kilns, the other on the insulation of gas retort settings, the latter deals with the thermal and mechanical features associated with the insulation of vertical and horizontal settings. The main work for the special benefit of the pottery industry is a general investigation on the sagger problem and on the possibility of minimizing the present financial losses caused by premature sagger failures in certain branches of the industry. E.P.R.

Fire brick. L. S. LONGENECKER. *Refract. Jour.*, **4** [42], 184 (1929); for abstract see *Ceram. Abs.*, **7** [9], 619 (1928). E.P.R.

Refractories. W. MIEHR, J. KRATZERT, AND H. IMMKE. *Refract. Jour.*, **4** [42], 184 (1929); for abstract see *Ceram. Abs.*, **7** [8], 545 (1928). E.P.R.

Value of insulation in the steel plant. L. M. MCMILLAN AND J. D. VANVALKENBURGH. *Refract. Jour.*, **4** [42], 185 (1929); for abstract see *Ceram. Abs.*, **8** [3], 192 (1929). E.P.R.

Refractories exhibit at British industries fair. ANON. *Refract. Jour.*, **4** [42], 187 (1929); see also *Ceram. Abs.*, **8** [5], 377 (1929). E.P.R.

Lining of furnaces. W. J. REES. *Refract. Jour.*, **4** [42], 192 (1929).—The selection and proper use of refractories for lining and maintenance of furnaces is of great importance. The essential properties and best methods of using the various refrac-

tories are considered in detail, special attention being given to the silica, semisilica, and fireclay refractories. The factors influencing durability are pointed out, and recent advances in the production of high-temperature refractories are described. E.P.R.

Production of silica brick. ANON. *Refract. Jour.*, **4** [42], 193 (1929).—The Dominion Bureau of Statistics at Ottawa reports that, according to finally revised data, the production of silica brick in Canada during 1927 amounted to 1,791,000, valued at $79,527; in the previous year 2,665,000, valued at $130,702, were produced. E.P.R.

Developments in electric furnaces. D. F. CAMPBELL. *Chem. News*, **138**, 219–20 (1929).—Improvements during the last two years are described, the relative performance of small and large induction furnaces is discussed, and the reasons for selecting the size of unit according to the work to be done are explained. A number of specific furnaces are examined for construction and performance, and new methods of lining are detailed. H.H.S.

Lowering power costs. D. G. MACINNES. *Eng. Times* (Toronto), **3** [1], 2 (1929).—Furnace upkeep is said to lose a large part of its cost if adequate refractories are used. The problem of refractories is to find a material, and a method of applying it, that will be immune to the destructive effect of fuels and at the same time will reduce heat loss to a minimum. The three forms, brick, cement bond, and plastics for monolithic lining, are discussed, and the importance of thin joints is emphasized. H.H.S.

Bauxite industry in Hungary. ANON. *Eng. Min. Jour.*, **124** [12], 455 (1927).—The Hungarian deposits are situated in the northern district, in the Vertes Mts., which extends northeast from the southwestern hills of the Vertes almost to the Danube River, and the southern district, in the Bakony Mts., on the northwest coast of Lake Balaton. It is estimated that the deposits in the two districts contain 200,000,000 metric tons. Most of the bauxite is used for the production of aluminum, nearly all of the material going to Germany. A.J.M.

Canadian crystalline graphite. H. P. H. BRUMELL. *Eng. Min. Jour.*, **124** [13], 494–96 (1927).—Graphite occurs in Canada in both forms, crystalline and amorphous, the latter being widely distributed, of little importance, and occurring usually as graphitoid shales, in no way comparable to the amorphous graphites of Mexico, Chosen, Italy, or Central Europe. Great importance is attached to the numerous extensive deposits of high-percentage disseminated ore in the Archaean rocks of Ontario and Quebec. A system of concentration has been developed, using oil-frothing flotation, whereby a recovery of about 95% of the graphite is made. The flake produced enters the crucible market. Three grades of finished stocks are being made: (1) assaying from 92 to 95%, coarser than 60-mesh, and used for crucible making; (2) assaying from 88 to 90%; and (3) assaying from 85 to 90%. An assay of the Quebec graphite stock shows the following: volatile carbon 0, graphitic carbon 93.87%, Fe_2O_3 1.35%, ash 5.38%. The Quebec graphite has a specific gravity of 2.268 with a refractory value of 1.007, compared with Ceylon graphite, with a gravity of 2.250 and a refractory value of 1.004. Outside of Ceylon, Madagascar, Canada, and the U.S. the only fields where crucible or lubricating flake graphite could be produced at a profit are in Bavaria, where the flake is very small, and in Greenland, Spain, Norway, and Indo-China. With the exception of the crystalline products of Canada, Madagascar, and the U.S., all natural graphites are crude and require milling before use. Artificial graphite is used almost entirely in the making of electrical articles although natural graphite is superior in some ways. A.J.M.

Ceramic substitutes for chromium. ANON. *Eng. Min. Jour.*, **124** [14], 559 (1929).—The important uses for chromium metal that have been developed recently make it desirable to find a substitute for the chromium used as a refractory. A refractory suitable to the purpose must have the following requirements: (1) resistance

to chemical reaction with fused metals, slags, and vapors; (2) resistance to deformation caused by a wide range of temperatures; (3) strength to withstand loads, blows, and shocks in a wide range of temperatures; (4) thermal conductivity; (5) durability (time of service); (6) uniformity; (7) resistance to erosion and spalling; (8) capability of conforming to accurate measure when molded. Chromite bricks are being used extensively in paper-pulp mills. These brick fulfill a need in the lining of the kilns used for the drying of pulp in the sulphite process, as they resist corrosion caused by the liberated gases in the kiln. A.J.M.

Austrian graphite and its sources. W. PETRASCHECK. *Eng. Min. Jour.*, **124** [15], 568 (1927).—Two districts, the Alps of Styria and the hills of Lower Austria, yield graphite. The graphite in the Alps consists of much disturbed and variously folded slates and limestones, also graywackes of Paleozoic age. The graphite seams are metamorphic coal seams of the upper Coal Measures, which have been changed to graphite by the sharp folding of the slates. The graphite is amorphous. The thickness varies from a few centimeters up to 16 meters. The crude ore ranges from 40 to 95% carbon. It is mined in galleries, sorted by hand, fine ground, and air-floated if it is not sold as crude. It is shipped in bags or wooden barrels. Styrian graphite is in great demand by reason of its purity. It is used for making crucibles by the Austrian iron and steel works. It is low in sulphur. Although not as durable as Ceylon or Madagascar graphite, that from Styria is much lower in price. The deposits of Lower Austria belong to a series of highly metamorphic rocks. The graphite is partly crystalline and partly amorphous. The ore is low in graphite carbon, averaging between 30 and 55%, so that it has to be concentrated by washing. The carbon in the refined graphite reaches 60% at best. A.J.M.

South Africa's corundum deposits. ANON. *Eng. Min. Jour.*, **124** [16], 610 (1927).—Corundum is produced from three types of deposits: crystal, boulder, and reef corundum. Crystal corundum consists of more or less broken crystals found in eluvial deposits, having been weathered out of and concentrated from the corundum-bearing reefs. Boulder corundum is the name given to aggregations of corundum crystals embedded in plagioclase matrix. Reef corundum occurs in veins intrusive into the basic rocks, which in turn, occur in the granites and gneisses which predominate throughout the corundum fields. The corundum reefs carry a varying percentage of corundum crystals, often as high as 45%. A.J.M.

Open-hearth end ports. B. FINNEY. *Iron Age*, **119** [10], 715 (1927). A.J.M.

Recuperators for the open hearth. W. H. FITCH. *Iron Age*, **119** [13], 920–22 (1927).—A new type of recuperator, using carbofrax tubes, is described. Large heat saving is claimed. A.J.M.

Open-hearth furnace discussion. ANON. *Iron Age*, **119** [20], 1451 (1927). A.J.M.

Flat suspended open-hearth roof. A. L. FOELL. *Iron Age*, **119** [25], 1814–15 (1927).—The advantages of a flat suspended roof are (1) increased life of front and backwalls due to relief of pressure from roof, (2) increased furnace volume, (3) elimination of possible roof falls during heating, and (4) elimination, to a great extent, of the human element in laying the roof. Good results were obtained. Silica tile 15 x $10^1/_4$ x 4 in. were used throughout. Twelve inches of tile are below the hanger and the 4-in. face was placed across the furnace. A.J.M.

Open-hearth furnace regenerators. F. H. LOFTUS. *Iron Age*, **120** [1], 10–12 (1927).—L. discusses in detail the various kinds of bricks used for checkers, method of calculating the proper capacity for checkers, effect of flue area on velocity, providing a constant flow of air, and a new type checker block. A.J.M.

Recuperators for open-hearth furnace. ANON. *Iron Age*, **120** [2], 71 (1927).—

The limit to the utilization of heat, probable amount of gain obtainable, rate of operation of furnace are discussed. With a flame temperature of 3100°F, beyond which it is inadvisable to go with present refractories, 788°F is the lowest point to which the stack temperature may be reduced by returning to the furnace the sensible heat in the waste gases. It is the concensus of opinion that the refractories at the present time limit the amount of sensible heat which may be recovered from waste gases. A.J.M.

Higher prices for fire clay and silica brick. ANON. *Iron Age*, **119** [14], 1040 (1927). A.J.M.

Gun for repairing furnace walls. ANON. *Iron Age*, **119** [18], 1309 (1927).—Firebrick cement pre-mixed with suitable refractories is thrown onto the surface to fill in depressions or burnt-out sections of brickwork. Unusual speed of application is claimed. Compressed air at 50 to 80 lbs. pressure is used. Steam is also satisfactory. A.J.M.

Furnace design. ANON. *Iron Age*, **119** [19], 1369–73 (1927).—Silica brick are said to have certain advantages when used in checkers. Deposits do not adhere to them so readily. In addition, heat seems to be absorbed and given off more readily. Glazed brick seem to have no advantage and one report states that glazing cuts down the efficiency. Illustrated. A.J.M.

Manufacture of aluminum from common clay. ANON. *Iron Age*, **119** [20], 1488 (1927).—The Clay Reduction Co. of Chicago has acquired of Segland Svendsen of Norway a method for the manufacture of alumina. This method, which is particularly for siliceous raw materials such as common clay and bauxite of high silica content, is said to bring a greater yield of alumina than methods now in use. It is stated that a pure silica of very high porosity is obtained as a by-product. A.J.M.

Gas permeability of refractory brick. F. A. WICKERSHAM. *Iron Age*, **119** [21], 1521–22 (1927).—A large amount of heat is lost in industrial furnaces by leakage of gases through the brickwork of the furnaces. The investigation of the gas permeability of bricks was started as a result of a study of the heat losses in an open-hearth furnace, particularly in the flues and regenerator chamber walls, or that part of the furnace below the floor level. It developed that in addition to the air drawn in through the saucer of the air valve, almost 100% excess air was being drawn in through the walls and flues between the air valve and the furnace proper. The time for a given amount of gas to pass through a brick bears no relation to the density of the gas. It was recommended during the discussion that the bricks should be coated both inside and outside with a slurry coating. In the furnace proper the bricks become glazed because of the high temperatures, and the passage of gases through them is much less. In a regenerator chamber the temperature is not high enough to form this vitreous glaze. A.J.M.

German method of firing silica brick. ANON. *Iron Age*, **120** [13], 912 (1927).—The Harbison-Walker Refractories Co. has secured American rights to a German method of firing silica brick. A car tunnel kiln, fired by producer gas and employing the regenerative principle will be used. Pyrometric control is used, with draft and pressure gages to give absolute regulation from the time the brick enters to the time it leaves the kiln. The firing temperature is 2700°F. The kiln is 500 ft. long and is said to be capable of producing 100 T. daily. This new installation is located at the E. Chicago plant. A.J.M.

Sizes and types of malleable foundry refractories sharply reduced. ANON. *Iron Age*, **120** [20], 1414 (1927).—Simplification of types of tap-out blocks will reduce the variations from 150 to 2; of shapes for side walls, bridge walls, etc., from 27 to 8; of shapes for bungs from 11 to 5. There is no change in the types of shapes for stacks. A.J.M.

Testing refractory materials under load at high temperatures. BERNARD LONG.

Sci. et ind., No. 181, 75–77 (1929).—Such tests may be divided into 2 classes: (1) Those in which the temperature is kept constant for a certain time and the bending or settling noted after cooling; (2) those in which the temperature is varied in a regular manner and noting the temperature at which the sample shows a settling of 1%. The procedure followed in either case may vary by the manner of heating (gas, electricity, etc.), the rate of heating, the method of determining the temperature (thermocouple, optical pyrometer), the dimensions of the test specimen, or the load carried by the specimen. L. describes a new testing apparatus which has the following features: The specimen (a cylinder 5 cm. high and 5 cm. in diameter) is placed inside a vertical cylindrical graphite crucible or tube which is heated by high frequency induction. The induction winding is a tube of copper wound spirally around the cylinder. A stream of water passes through the tube which is connected to the terminals of a high frequency generator. The load, which consists of lead shot, is applied directly by means of a tubular rod which rests on the specimen. The temperature is read by a disappearing filament optical pyrometer, the light from the specimen traveling upward and then being deflected at right angles to the pyrometer by means of a total reflection prism. The vertical movement of the rod which transmits the load is recorded automatically. The tests and results fall into 3 classes as follows: (1) *Silico-aluminous refractories:* Two bricks were tested. Brick A had the following analysis: 69.1% SiO_2, 27.8 Al_2O_3, 1.5 Fe_2O_3, 1.30 TiO_2, 0.23 Na_2O. Brick B contained 53.92% SiO_2, 42.0 Al_2O_3, 1.95 Fe_2O_3, 1.85 TiO_2, 0.28 alkalis. The results are expressed by stating the temperatures at which the settling or bending attains 2, 5, and 10% of the length of the specimen just before deformation begins. The following results were obtained with a load of 2 kg. per cm.²

Brick (°C)	2% (°C)	5% (°C)	10% (°C)
Brick A, fired at 1220	1430	1450	1470
Brick B, fired at 1200	1430	1480	1530
Brick A, fired at 1320	1455	1475	1485
Brick A, fired at 1460	1480	1490	1500
Brick B, fired at 1320	1440	1490	1540
Brick B, fired at 1460	1480	1500	1550

The results show that the resistance to deformation under load at high temperatures is increased by increasing the temperature to which the refractory is fired. (2) *Siliceous refractories:* Three bricks were tested. Brick I had a true specific gravity of 2.34 and was well inverted. Deformation started at 1580° and crushing occurred at 1585°. Brick II had a true specific gravity of 2.45 and contained considerable free quartz. The expansion increased suddenly at 1425° and continued at the same rate to 1525° showing the inversion of the quartz. Crushing took place at 1590°. Brick III had a true specific gravity of 2.32 and was well inverted. Deformation started at 1645° and crushing occurred at 1650°. Siliceous products are preferable to silico-aluminous refractories for temperatures above 1450°C. Loads of 2 kg. per cm.² are rare in industrial furnaces and when lower than 2 kg. it is possible to use silico-aluminous refractories. (3) *Special refractories:* A bauxite brick (61.20% Al_2O_3, 6.95% Fe_2O_3) showed a deformation of 5% at 1400°C. A silicon-carbide brick bonded with clay and fired to 1200° showed a deformation of 5% at 1470°. Another silicon-carbide brick made of 75 parts silicon-carbide and a special bond, and fired to 1450° showed a 5% deformation at 1780°, crushing following soon after. A zircon brick showed 5% deformation at 1550°. Illustrated. A.J.M.

The volume increase of brick upon heating. P. I. GALKIN. *Trans. State Expt. Inst. Silicates* (Moscow), No. 21, 107–10 (1927).—G. presents data on firing shrinkage and expansion of various clays. (*C.A.*)

Melting-point curves of refractory oxides. H. v. WARTENBERG, H. LINDE, AND R. JUNG. *Z. anorg. allgem. Chem.*, **176**, 349–62 (1928).—The furnace used in this work and its method of operation are described in detail. The heating chamber is composed of ZrO_2 in the form of a tube, and the heat source is an oil-O_2 burner with a H_2O-cooled tip. Temperatures up to 2600° can be attained. The material to be examined is formed into a hook by means of a suitable binding material, and this is attached to a ZrO_2 rod, the softening point and melting point being determined by observing the temperature at which the hook bends or drops form. A control run on a known system (CaO–Al_2O_3) indicated reasonable accuracy. Study of the system: ZrO_2–Al_2O_3 shows that softening and melting point can be determined in mixtures containing up to 20% ZrO_2; from 20 to 60% ZrO_2 only melting point can be determined, due to the eutectic (melting at 1920°); with 80% ZrO_2 only softening occurs. No indication is given of the formation of an ortho- or meta-zirconate ($Al_4Zr_3O_{12}$ with 35.5% Al_2O_3 or $Al_2Zr_3O_9$ with 21.6% Al_2O_3). In studying the system CaO–ZrO_2, bakelite lacquer is used as a binder in preparing the sample. Although CaO melts at 2580° and boils at 2850°, loss of CaO due to vaporization begins to occur at about 2350°. A eutectic is shown at about 40% ZrO_2 and 2230°, with a second eutectic indicated in the vicinity of 75% ZrO_2 (melting at 2380°). The meta compound $CaO{\cdot}ZrO_2$, containing 69% ZrO_2, probably exists, but doubt is thrown upon the ortho compound $2CaO{\cdot}ZrO_2$. (*C.A.*)

BOOK

Diatomite, Its Occurrence, Preparation, and Uses. V. L. EARDLEY-WILMOT. Mines Branch, Department of Mines, Ottawa, Canada.—The author outlines the life history of the diatom, and the subsequent formation of diatomite. The uses of this material are enumerated and some of them are described in detail. Methods of examining and sampling deposits and the tests necessary to determine the suitability of diatomite for its various uses are given. Markets and prices are discussed, the imports and exports of the various countries all over the world being given, as well as the approximate quantity used in each of the different Canadian industries. All the known occurrences of diatomite in Canada, of which there are about 120, are tabulated and in most instances a complete analysis is provided. Mining methods, preparation for the market, and the manufacture of some of the various diatomite products, are described, with some notes on the cleaning and preparation of diatoms for mounting on slides. A bibliography is included. Maps indicating the localities of all the known Canadian occurrences accompany the monograph. Reviewed in *Can. Chem. Met.*, **13** [3], 26 (1929). E.J.V.

PATENTS

Wall construction. FRANK H. DUNBAR. U. S. 1,707,347, April 2, 1929. A wall comprising a series of plates each having an outwardly extending web and an upwardly extending flange on the web adjacent the outer end, the flanges and webs of adjacent plates being in alignment to form supports for continuous courses of tile.

Aluminium oxide. G. A. BLANC. Brit. 304,289, March 13, 1929. Alumina is obtained in granular as opposed to pulverulent form by decomposing the hydrated chloride or nitrate within an apparatus in which the material is not subjected to friction, shock, pressure, or other mechanical stresses during its decomposition. When using aluminium chloride a pseudomorphosis takes place. Muffle or rotary furnaces may be used.

Refractory substances. METALLGES. A.-G. Brit. 304,729, March 20, 1929. A heat-insulating refractory material is formed of magnesium ortho-silicate either synthetically produced or a natural product such as olivine, peredolite, or dunnite. Preferably a porous material is formed by agglomerating grains of olivine, etc., with or without a binding agent. Chemical compounds having a cementing action may be used. The porosity of the product may be increased by adding to the granular raw materials

substances which are eliminated by heat or which generate gases when heated, such as sawdust, peat powder, cork waste, coal, maize grains, rice husks, magnesium carbonate, magnesium nitrate, and aluminium nitrate, or substances which generate gases when water is added such as aluminium, calcium, and carbides. The magnesium orthosilicate may be formed from serpentine or other magnesium hydro-silicates by heating with magnesium oxide, magnesite, etc.

Refractory objects. GEORGES L. CHAUDRON AND AUGUSTE L. DESMARQUEST. French 643,473, April 1, 1927. Crucibles or other refractory objects are made by baking commercial MgO in an electric furnace, grinding and making into a paste with a suitable binder, *e.g.*, tar. This paste is afterward molded under high pressure and baked out of contact with a flame to 1400°, then rebaked to between 2000 and 2200° in an electric resistance furnace. (*C.A.*)

Refractory material. STAHLWERKE RÖCHLING BRUDERUS A.-G. AND ALFRED KROPF. Ger. 469,433, Dec. 19, 1926. Ta powder, which may contain up to 10% of impurity, is mixed with graphite in the proportions 3:2 with the use of a binder, *e.g.*, pitch or molasses. The mixture is molded under pressure, dried at 300 to 500°, and then heated at 2000 to 3000°. The molded piece may be given a coating of graphite before heating. The products may be used as electric-resistance heaters or for making crucibles, furnace linings, etc. (*C.A.*)

Terra Cotta

Terra cotta and buff brick. ANON *Arch. and Bldg.*, **61** [2], 39–40 (1929).—The chief materials of the exterior of the Chanin Bldg., New York City, are buff brick and terra cotta selected for the tones which are produced by the weathering process rather than initial appearance. The fronts of stores on the street level are of bronze, Belgian black marble, and plate glass. Above the fourth story inclosing the windows is a frieze of terra cotta, decorated with plant forms in conventional figures. Details of terra cotta are used for ornamentation of the main building and tower. E.P.R.

Use of terra cotta and brick in building. LEON V. SOLON. *Arch. Rec.*, **63** [4], 289–97 (1929).—The Park Ave. Building, New York City, disregards fictitious values. Every substance depends for interest and effect upon its own virile and substantial properties, revealing a discernment of expressive capabilities akin to that active during the inception of historic types. Brick, the principal structural material, though practically uniform in hue, sets the keynote of the tonal gamut, one tone being used in the plain main masses, another in triangular pilasters, etc. In place of separate silhouettes they are repeated, each treated with a color, magenta red, black, ochre, and green-blue, all mats except the black. The ochre formed the liaison between the brick and terra cotta groups. The general harmony of glazes was determined by placing, experimentally, full size plaster models, sprayed in color, at distances of about 250 ft. Color is introduced in mosaics by use of some glass of very original design. The lighting fixtures embody new principles capable of varied development. E.B.H.

Vertical lines in architecture. ANON. *Arch. and Bldg.*, **61** [2], 41 (1929).—The exterior of the Bartholomew Building, New York City, is of red brick with a minimum of trimming, making a structure of severely plain appearance with emphasized vertical lines. Verticality is emphasized by the use of different shades of brick varying from light buff to deep red. The public hall has a floor of travertine with marble borders and mosaic inserts. The walls are panelled in marble. E.P.R.

Test for roofing tiles. ANON. *Brick Clay Rec.*, **74** [7], 484 (1929).—Following a series of physical tests upon roofing tiles of various kinds and makes, the California Institute of Clay Products propounded a set of recommendations to architects indicating what should be specified for roofing tile specifications. The recommendation reads as

follows: "The roofing tile shall not absorb more than 15% of the constant dry weight of the tile immediately after immersion in water for 48 hours. The tiles shall be capable of sustaining without rupture or crack a load of at least 400 lbs. carefully applied at the center point of the tile when supported on four points of bearing 6 in. each side of the centerpoint of the tile, making a 12-in. span. A test result shall consist of the average of 5 tiles tested." A standard method for making these tests was developed. E.J.V.

Standard valuation of the common square stoneware tiles. OTAKAR KALLAUNER. *Sprechsaal*, **61** [25], 485–90 (1928).—The results of an investigation on this subject are as follows: (1) as a rule the thicker (stronger) the tile (measuring 15 x 15 x 1.5 cm.) the greater were their weights, uniformity of their upper surface and resistance to impact; (2) the less the absorption, the less, on the whole, the abrasion; (3) of different colored tiles the gray ones appear to be the most dense, strongest, abraded least and were most resistant to acids. These properties as obtained on the red and black tiles were just the reverse. R.A.H.

Constant pressure gravity tank for spraying slips and glazes. R. F. GRADY. *Ceram. Ind.*, **12** [4], 450–51 (1929).—In spraying two or more colored glazes simultaneously, the main source of trouble has been that of the changing ratio of each member of the combination, caused by the alternate emptying and filling of the gravity feed tanks used for holding the coating material. This change in heads of material on the glaze outlet caused a serious color variation, especially when the combination was made up of three contrasting colors. The waste of time and material and the serious color variations caused by the various heads, readily showed the necessity of more modern equipment. All of the known types of spraying equipment were studied with the idea that the open type gravity containers would be displaced with suitable modern equipment. After considerable thought, the idea was conceived of incorporating the principle of the submerged tube, as utilized in the Mariotte. An experimental tank was made and tested and proved to be so satisfactory that the entire plant was supplied with this type of equipment. F.P.H.

BOOK

Practical Requirements of Modern Buildings. EUGENE CLUTE. The Pencil Points Press, New York. 240 pp., 200 illustrations. Price $6.00. E.P.R.

White Wares

Alabax porcelain lighting fixtures. ANON. *Arch. and Bldg.*, **61** [3], 98 (1929).—Lighting fixtures manufactured by Pass & Seymour, Inc., and marketed under the name of "alabax" are made of exceptionally high-grade porcelain which is exceedingly resistive to wear and may be cleaned readily. Of particular interest is the line of colors in which they are manufactured. E.P.R.

Royal crown derby. ROBERT NELSON AGAR. *Crockery and Glass Jour.*, **107** [3], 45 (1929).—The history of the Derby china industry. E.P.R.

Packing in the whiteware industry. H. E. HULDSCHINSKY. *Ber. deut. keram. Ges.*, **10** [1], 6–11 (1929).—Specifications covering the methods of packing of white ware required by the transportation agencies of Germany are described and criticized. F.P.H.

Plant control in the whiteware industry. H. UNTUCHT. *Ber. deut. keram. Ges.*, **10** [1], 49–55 (1929).—Plant control methods used in the sanitary, wall tile, and general ware industries of Germany are described. The following tests were carried out on the various raw materials: (1) moisture content of clays, (2) rational analysis of clays, (3) sieve analysis of feldspar, (4) chemical analysis of feldspars expecially the Fe_2O_3, K_2O and Na_2O contents, (5) fired color of the feldspars, (6) firing behavior of glaze materials when mixed, (7) drying and firing shrinkage, (8) plasticity of clays and

kaolins according to method of Pfefferkorn, (9) casting behavior of the clays, (10) soluble salts in the clays, and (11) amount and character of organic substances in clays. A number of methods were employed for slip control including rational analysis, sedimentation analysis, p_H value of slip and various materials added to slips, dye-absorption method, specific gravity of slip, and viscosity of slip. The finished products were usually subjected to the following tests: (1) impact strength, and (2) resistance to crazing according to method of Harkort, or variations of this method. F.P.H.

Plant control in the manufacture of stoneware and floor tile. R. RIEKE. *Ber. deut. keram. Ges.*, **10** [1], 20–24 (1929).—A questionnaire was sent to various stoneware and floor tile manufacturers requesting information on the methods used in controlling the quality of their products. The following tests were carried out on the raw materials: (1) chemical analyses, (2) rational analyses, (3) sedimentation analyses, (4) strength in the dry state, (5) presence of soluble sulphates, (6) action of deflocculators on the clays, (7) casting quality of the clays, (8) softening behavior of the feldspars, and (9) determination of the purity of coloring oxides used. The fineness of the glaze materials and the consistency of the glaze slips are carefully controlled. The chemical analysis of the glazes consumes too much time for the average plant. Temperature and humidity control equipment is employed in the drying process. The firing process is controlled by means of cones and various temperature measuring devices. The testing of the finished product in the floor tile industry is mainly one of visual inspection and sorting according to size and colors. The physical properties of the stoneware are determined from time to time as a means of control. F.P.H.

Plant control in the dutch tile oven industry. H. HARKORT. *Ber. deut. keram. Ges.*, **10** [1], 43–48 (1929).—The replies to the questionnaire sent to the manufacturers of dutch tile ovens concerning the methods used in plant control of the quality of their products are summarized by Harkort, a member of the Plant Control Committee of the German Ceramic Society. F.P.H.

Plant control in general and fancy china industries. GERHARD KLITZKE. *Ber. deut. keram. Ges.*, **10** [1], 55–63 (1929).—The raw kaolins are tested for water content, fired color, firing shrinkage, rational analysis, and plasticity. The sagger clays are tested for moisture content, fired color, shrinkage, sagging during firing, and quartz content. Chemical analyses are made on the nonplastics. The consistency of the glaze slip is carefully controlled. The finished products are tested for (1) transparency, (2) impact strength on edge and on bottom of the pieces, and (3) resistance to sudden temperature changes (quenching test). The test methods are described. F.P.H.

Plant control in the electrical porcelain industry. OTTO KRAUSE. *Ber. deut. keram. Ges.*, **10** [1], 64–68 (1929).—The chemical and mineralogical composition of all raw materials is carefully controlled. The effect of the variations in these compositions on the finished products must be known to accurately control the product. F.P.H.

Champion Porcelain Co. doubles furnace capacity. ANON. *Clay-Worker*, **91** [4], 324 (1929).—Contracts have been signed for the immediate construction of a second Dressler tunnel kiln, representing an investment of $250,000 and doubling the present capacity of the plant. The old kiln, which has been in service for eight years, is considered one of the finest installations ever made in regard to combustion control, every possible variation in behavior and operation being accurately recorded. This includes temperature recorders, delicate automatic draft correcting devices, gas analyses recorders, etc. The second unit will include many improvements. In the commercial development of sillimanite a complete line of sillimanite chemical laboratory ware has been introduced. The qualities of sillimanite are discussed. E.J.V.

Another Homer Laughlin China Co. plant. ANON. *Clay-Worker*, **91** [4], 325 (1929).—A proposed five tunnel kiln plant, to be known as No. 8, at Newell, W. Va.,

will cost $1,500,000, employ 800 more pottery workers, and increase the company's capacity to the equivalent of 160 upright kilns. The new unit will include one large bisque, two glost, and two decorating kilns, all tunnel types. The output of the proposed plant will equal the combined production of Nos. 6 and 7. E.J.V.

Glaze affects quality and breakage of porcelain insulators. H. HANDREK. *Keram. Rund.*, **35,** 144–47 (1927).—The glaze has little effect on the electrical properties of glazed insulators. Insulator test pieces having a thickness of 2.3 mm. comprising a body thickness of 2.0 mm. and a glaze thickness of 0.3 mm. showed a break-down voltage of 27.6 kv./mm. An unglazed body of the same thickness gave 31.1 kv./mm. and a piece of glaze of the same thickness, 19.0 kv./mm. For resistance to flash-over the nature of the surface of the glaze is of much more importance than the composition of the glaze. The nature of the glaze has much greater effect on the mechanical than on the electrical properties. The relative tensile strengths of glazed and unglazed insulators depend to a great extent upon the character of the surface layer. Transverse strength is related to tensile strength and these glazed insulators which have a higher tensile strength than unglazed will also show a higher transverse strength. Compressive strength is usually markedly higher on glazed than on unglazed insulators. The glaze is of great importance in the resistance to change in temperature. The tensile strength and elasticity of the glaze and the relative coefficients of expansion of glaze and body are mainly responsible for the resistance to temperature changes. H.I.

PATENTS

Insulator. KENT A. HAWLEY. U. S. 1,706,488, March 26, 1929. In combination with an insulator of the pin type having outer and inner skirt portions, a protective guard of metal including a bottom portion, an upstanding outer side wall and a central upstanding sleeve portion, the outer wall portion of the guard being detachably engaged with and lying against the inner periphery of the outer skirt portion of the insulator, the bottom portion defining a substantial closure for the bottom of the insulator, and the upstanding sleeve portion being located within the confines of the inner skirt portion in spaced relation thereto and to the pin.

Insulator. OTTO DOELTER. U. S. 1,707,054, March 26, 1929. In an insulator, a body portion having flared bell shaped extensions formed thereon, the extensions extending in opposite directions from each other, a projection formed in each of the bell shaped extensions, reinforcing member embedded in the body portion and having an eye extending into and embedded within each of the projections, and surrounding an eye formed in each of the projections and drip rings formed on each of the projections at a point substantially midway between the last named eyes and the body portion for the purpose specified.

Low-loss insulator. LEON T. WILSON. U. S. 1,708,038, April 9, 1929. An insulator having a flange extending outwardly therefrom, a groove in the flange for carrying a line conductor and a tie-wire, an interior bore within the insulator whereby it may be mounted upon a supporting pin, the groove being located well below the top of the supporting pin and the diameter of the groove being more than twice the diameter of the internal bore, and a groove extending upwardly into the flange from the underside thereof to a point well above the external groove and approximately as high as the interior bore so that an air-space will intervene between the external groove and the supporting pin.

Insulator. GRANDON E. ECKERT. U. S. 1,708,876, April 9, 1929. (1) A link for insulators, comprising a bearing loop area longitudinally channelled to facilitate its transverse deformation under load. (2) For use in a supporting fitting provided with seats, an insulator-engaging link of generally horseshoe shape, comprising a bar of metal having its ends offset toward each other to form shouldered heads adapted to freely

engage the seats of the supporting fittings, the outer surfaces of the heads being rounded and slabbed off, the surfaces merging substantially without break with the outside of the link to facilitate the threading of the link through a curved passage formed in the insulator.

Pottery making. W. J. MILLER. Brit. 304,311, March 13, 1929. Apparatus for manufacturing pottery comprises portable mold-carrying trays provided with bosses, for positioning molds thereon in definite spaced relation, means for positioning the trays adjacent apparatus for shaping the ware, mold-transfer members and mechanism in the form of cam-operated levers, for actuating the members in synchronism with the shaping mechanism to effect periodic removal and replacement of the molds in a substantially horizontal plane relatively to the trays. Mechanism for feeding plastic material to the molds at desired times may also be provided. The mold trays are mounted in series on a conveyer chain passing over sprockets disposed in a drying chamber. The mold-transfer members are connected between rods disposed at each side of the machine, such rods being pivotally attached at their ends remote from the trays to levers. A movable frame carrying a shaping tool is adapted to be reciprocated vertically through the medium of a cam and lever. Plastic material is automatically fed to the molds. The containers for the plastic material are mounted on the frame, and cam and gear means operatively connected. The feeding of material is operated in timed relation to the reciprocation and rotation of the chucks. Instead of the several molds on a tray being operated on simultaneously, the shaping and feeding mechanism may be mounted as a unit which may be movable on rails, the mechanism being shifted along a tray so as to operate successively upon the molds carried thereby. Brit. 284,692 (see *Ceram. Abs.*, **7** [6], 383 (1928)) is referred to.

Equipment and Apparatus

Notes on dry-pan and wet-pan operation. J. M. GALLAHER. *Jour. Amer. Ceram. Soc.*, **12** [5], 347–50 (1929).—The following points are discussed: (1) improvement in dry and wet pans with the introduction of high capacity heavy-duty units to replace several units and requiring less power and maintenance; (2) engineering cost data with respect to economical operating speeds, results of which were obtained from an actual installation calculated on an average power rate; (3) relation of rotation rate to capacity, considering the effect of the speed of rotation on the efficiency of the emptying device; and (4) the optimum size for economical operations at various capacities, an answer to which cannot be given without a thorough study of the many factors involved, some of which are discussed in the article.

A sandblast abrasion test for glazes. EDWARD SCHRAMM. *Jour. Amer. Ceram. Soc.*, **12** [5], 356–59 (1929).—A method is described for determining the abrasive hardness of glazes by means of a sandblast apparatus. Consistent results are obtained and data are given showing the relative hardness of several types of glaze.

Operating a pit drill with steam from the power shovel. ANON. *Brick Clay Rec.*, **74** [8], 550 (1929).—An interesting case of how the Paxton Brick Co., Paxtonville, Pa., increased the speed of drilling in its clay pit by using an air drill, rigged up for operation by steam, attached to the dipper of the steam shovel. By use of this combination the drilling time was cut from 10 to 14 hrs. down to 2 hrs. E.J.V.

Relative merits of jaw and gyratory crushers. W. T. W. MILLER. *Eng. Min. Jour.*, **124** [6], 208–209 (1927).—The merits of the gyratory crusher are its high capacity and low power consumption combined with bearings properly lubricated and kept reasonably free from dust, and, in some respects greater ease in feeding. Its disadvantages lie in the excessive headroom required, in the relatively smaller feed size which it takes, and in the fact that the size of the finished product is not easily adjusted;

also, in some cases, the difficulty of renewing the wearing parts is a drawback to its usefulness, and the bearings have to be maintained in good condition to avoid loss of output. The jaw crusher is not as efficient in regard to output and power consumption, but in the smaller sizes it will take larger material, although it is not so easy to maintain the regularity of the feed. The finished size of the crushed product can be varied with greater freedom and the stroke can be altered to meet any change in the working conditions. The wearing parts are more readily accessible, but the bearings are not so well protected or lubricated. Normal wear does not reduce output and the headroom required is moderate. A.J.M.

Reverse current classifier betters grinding results. ANON. *Eng. Min. Jour.*, **124** [6], 239–40 (1927).—There are two distinct units, the rotary and the superfine. The rotary alone is used where specifications are not rigid. The rotary and the superfine are combined for a very fine product, or where the material to be ground is difficult to handle. The fan is located on the same center line as the mill, but beyond the classifier, and no material passes through it. Air is blown into the mill through the discharge end. The current turns in the mill, carrying back with it the finished material together with a small amount of oversize. If the rotary alone is used, the oversize settles out here and is blown back into the mill for regrinding, while the finished product is carried up a pipe to the product collector. If both rotary and superfine are used, the first separation takes place in the rotary and a second separation occurs in the superfine, the finished product going from there to the collector, and the oversize back to the mill. In this system the air currents can be reversed at any point. A sketch shows the application of this apparatus to the cement industry. A.J.M.

Portable crushing plants. W. T. W. MILLER. *Eng. Min. Jour.*, **124** [9], 333–36 (1927). A.J.M.

Development of primary breakers. W. T. W. MILLER. *Eng. Min. Jour.*, **124** [11], 410–12 (1927). A.J.M.

Single-roll crushers. W. T. W. MILLER. *Eng. Min. Jour.*, **124** [13], 490–92 (1927). A.J.M.

Design and application of swing-hammer crushers. I. W. T. W. MILLER. *Eng. Min. Jour.*, **124** [23], 888–92 (1927). **II.** *Ibid.*, **124** [24], 930–33 (1927). A.J.M.

Selecting grinding media. H. HARDINGE. *Eng. Min. Jour.*, **124** [18], 695–98 (1927).—H. presents a detailed discussion of the subject. A.J.M.

Continuous vacuum filter. ANON. *Eng. Min. Jour.*, **124** [12], 480 (1927).—The new filter, made by the Dorr Co., is of the drum type with the filter medium on the inside. The material to be filtered is inside the drum and is thus kept agitated without the use of a filter tank. A.J.M.

Removing cement clinker rings. ANON. *Eng. Min. Jour.*, **124** [13], 497 (1927).—Clinker rings often form in revolving cement kilns and greatly lessen the cross-sectional area at certain points. A new gun, mounted on a special frame and shooting a lead slug which weighs 3 oz., has been found very suitable for removing the clinker rings. The gun has a 30-in. barrel, 8-gage, with solid breech block. Special ammunition is used. The method of operation is to mount the gun upon the front of the kiln and to shoot slots or keyways out of the ring. Then the kiln is started and a few revolutions generally cause the remaining portion of the clinker ring to fall. Illustrated. A.J.M.

Modern clay-washing methods. A. ANABLE. *Eng. Min. Jour.*, **124** [14], 566 (1929); for abstract see *Ceram. Abs.*, **7** [11], 774 (1928). A.J.M.

Comparing efficiencies of centrifugal pumps. G. H. GIBSON. *Eng. Min. Jour.*, **124** [21], 813 (1927).—Sizes of suction and discharge nozzles, and piping arrangement, must be considered. A.J.M.

Crushing plant flow sheets and system of descriptive symbols. C. W. TANDY. *Eng. Min. Jour.*, **124** [22], 847–50 (1927). A.J.M.

Flexible coupling for high operating speeds. ANON. *Iron Age*, **119** [3], 221 (1927). A.J.M.

Indicator of gallons of oil in tanks. ANON. *Iron Age*, **119** [10], 720 (1927). A.J.M.

Carbon arc machine makes welds under water. ANON. *Iron Age*, **119** [15], 1077 (1927). A.J.M.

De-rusting piping. F. N. SPELLER, E. L. CHAPPELL, AND R. P. RUSSEL. *Iron Age*, **120** [1], 31 (1927).—Rust is removed from pipe systems by an acid solvent. The rust solvent used is a strong, hot solution of HCl (prepared by mixing commercial acid with hot water) to which an inhibitor is added to protect the steel pipe. A.J.M.

Antifriction belt conveyer idler. ANON. *Iron Age*, **120** [3], 147 (1927). A.J.M.

Equipment for welding with atomic hydrogen. ANON. *Iron Age*, **120** [6], 343 (1927). A.J.M.

Cadmium plating resists rust. C. H. HUMPHRIES. *Iron Age*, **120** [7], 401 (1927). A.J.M.

Control apparatus for plater. C. KOCOUR. *Abrasive Ind.*, **10** [4], 33–34 (1929).—The degree of acidity of a nickel solution is important for good results. An old method of determining this factor was litmus paper but this did not suffice. As titration did not measure the p_H or degree of acidity there was need for some type of instrument that would accomplish this. The physical apparatus for determining the p_H was far too technical for the ordinary individual to operate and too costly to install. As a result two H-ion comparators of p_H testers were developed. By the use of these inexpensive instruments a plater could quickly and economically determine the p_H of his nickel solutions and if in error promptly correct them. The Bureau of Standards has worked out data giving the best operating p_H for nickel solutions. The p_H of acid zinc solutions can be tested in the same manner. The acidity of the acid copper plating solution is so high that it is impractical to try to control this solution by means of its p_H. An instrument, therefore, has been developed which not only determines the acid present but also the metal in solution, both determinations being rapid and to the accuracy necessary. Cyanide solutions must still be controlled by chemical analysis as no instruments have been developed for their easy control. The metallic nickel in plating solutions has formerly been controlled by the periodic analysis of the solution either by the electrolytic or titration methods. The former method was long and required an appreciable investment in apparatus. As a result the nickel comparator was developed. This instrument takes advantage of the fact that the green color of nickel solution is directly proportional to the nickel present. By comparing a portion of the solution of standard solutions of nonchanging intensity the amount of nickel can thus be very rapidly determined. E.P.R.

Electrical unwatering of Portland cement slurries. LEO G. HALL. *Cement, Mill, and Quarry*, **33** [4], 28–34 (1928).—In laying out a plant with view to unwatering the slurry before firing, considerable additional economy can be affected both in investment and in operation. Such items as the use of shorter kilns for burning the dried slurry, and the reduced requirement in coal preparation equipment, for instance, should more than counter-balance the investment in an unwatering plant. There is much direct experimental evidence in support of the behavior of mineral gels. Freshly prepared suspensions of ground quartz or corundum are readily unwatered to 12% or even 10% water content. Gels of silica or alumina, on the other hand, made by rapid precipitation from solutions of their salts, will hold from 60% to several hundred per cent of

their dry weight in adsorbed water against the electric current. Such gels usually have a spongy or cellular structure and behave like sponges. Any ordinary earth may be made to take up and retain in adsorption almost any desired amount of water by the addition of a suitable organic or inorganic gel. This is done in the ceramic industry to make clays more plastic. Practice in commercial operation in purifying clays gives about $1^1/_2$ minute exposure to the electric current, obtaining a blanket of clay from $^1/_4$ in. to $^3/_8$ in. thick. It is well known that a longer exposure to the current, with a resultant thicker deposit of material on the anode gives a greater density of product. The reason for this is that the process works in both directions, that is, not only does the solid matter travel to the anode, but the water at the same time must travel away from it, setting up a counter current action. The solid matter, however, forms a sort of capillary diaphragm which opposes great resistance to the flow of water and materially slows down its removal from the region of the anode. That part of the deposit next to the anode loses its free water first and is drier than the outer layers of the deposit. The longer the treatment, the thicker and drier this dry layer becomes. The density of the product as a whole is merely the average of the densities of the different parts of the deposit. A longer exposure to the electric current therefore results in increasing the average density or dryness by increasing the proportion of the deposit which has reached its ultimate dryness. Where a high degree of dryness is desired it is also necessary to lay out the machine and adjust its speed so that ample provision is made for draining off the loosely adherent water on the surface of the deposit as it comes out of the suspension. The belt type of machine is more favorable for this purpose than the drum type as such provision can readily be made without disproportionately increasing the size of the whole machine. There are three ways in which power is consumed in electrophoresis: (1) in decomposition of the water; (2) in overcoming the electrical resistance of the suspension; (3) in moving the solids through the liquid, that is, in overcoming the frictional resistance between the suspended material and the water. The current used in overcoming the electrical resistance of the suspension is always a very small percentage of the total. In this, kaolin slips are apparently slightly more favorable than slurries; but this difference amounts to not more than 1 or 2% of the whole consumption. E.P.R.

Advances in machinery design. P. R. PERKINS. *Cement, Mill, and Quarry*, **34** [3], 64–65 (1929).—A new rotary drier unit has been developed and a number of complete units installed. Complete control of temperature is assured and advantages of direct heat is had without burning or scorching the material. Both direct heat types using products of combustion, and indirect heat types using air only for drying are now available. Both types are fitted with automatic temperature controls which reduce consumption of fuel to a minimum. E.P.R.

Drying unfired ceramic articles. W. PUKALL. *Sprechsaal*, **61** [22], 430–32; [23], 450–53 (1928).—Among the conclusions which P. obtained from an investigation on drying are the following: (1) the drying of clay and clay bodies with ordinary temperatures is essentially carried on from the surface with nonuniform drying of the inner layers; (2) under these circumstances considerable strains are introduced in the articles; (3) these strains are measurable and were found in both lean and fatty clays; (4) they are independent of the strength of the ware and as a rule reach their maximum before the ware is completely air-dried. R.A.H.

Vibrating screen. ANON. *Brit. Limemaster*, Oct. 1928; *Rock Prod.*, **32** [6], 95 (1929).—An English screen that is said to be exceptionally efficient in separating the finer sizes is described. It is called the "Vicona" separator, and is shown in section. The screening portion consists of two or more conical screens on a frame that is vibrated by a cam. In one form only two screens are used, but in another form there are three

screens to produce one more size. The frame is hung on two points and rests on a cam for the third of a three point suspension. The cam is made so that it gives both a vertical and a horizontal motion and this combination is said to be very effective in cleaning the screen and keeping it from blinding. F.P.H.

Developments in temperature indicating, recording, and control instruments during 1928. D. L. MATHIAS. *Instruments*, **2**, 23–25 (1929). (*C.A.*)

BOOKS

Operational Circuit Analysis. VANNEVAR BUSH. 392 + x pp. John Wiley & Sons, Inc., New York, 1929. Price $4.50.—Covers circuits of electricity, thermics, mechanics, hydraulics, etc. A brief survey of Fourier analysis is included. H.H.S.

Vibration Problems in Engineering. S. TIMOSHENKO. D. Van Nostrand Co., New York. 348 pp., price $4.50.—The fundamentals of the theory of vibration are developed and their application to the solution of technical problems is illustrated. The demands of industry, the use of large high-speed machines and devices have brought this aspect of mechanical engineering design to the front. Engineers are taking a new interest in these studies because of their direct application and T. has made a splendid and helpful contribution to engineering through this thoroughly and carefully prepared development of the whole subject. The Westinghouse Electric and Manufacturing Co. placed at the disposal of T. facilities for the study of actual cases of vibration so that a splendid balance between theory and practical problems has been maintained. Reviewed in *Can. Chem. Met.*, **13** [3], 48 (1929). E.J.V.

PATENTS

Vibrating screen. MYRON A. KENDALL. U. S. 1,705,619, March 19, 1929. In combination, a screen frame, a screen element secured across the frame, a support, means for angularly adjustably mounting the frame on the support, a motor fixedly mounted on the support, and an unbalanced weight secured to the shaft of the motor for vibrating the frame.

Cement kiln and feeder control. ROBERT W. RYDER. U. S. 1,706,592, March 26, 1929. In combination with a revolvable kiln and a material feeder therefor, a variable speed electric motor arranged to drive the kiln and a second variable speed electric motor arranged to drive the feeder, electrical circuits including a separate controller box for each motor, the controller boxes being equipped with fixed contact parts and movable contact parts and mechanical means connecting the moving contact parts of the controller boxes to effect simultaneous operation of the same.

Device for spraying paints, lacquers, or other liquids. AUSTIN H. DOWNS. U. S. 1,706,875, March 26, 1929. A paint spraying device including a nozzle member having an air passage and a cylindrical bore communicating with the air passage, the nozzle member having a slot in its tip or outlet portion communicating with the cylindrical bore, the slot being less in width than the diameter of the bore whereby shoulders are provided at the junction of the bore and slot to form means for abruptly changing the direction of the air before it enters the slot and means to discharge a stream of material rearwardly of and spaced from the shoulders whereby to cause the air to intercept and flow across the stream of material at points within the nozzle member.

Rotary-kiln feed. ROLAND E. MINOGUE. U. S. 1,707,191, March 26, 1929. The combination of a rotary kiln, an annular chamber surrounding the kiln, means for conducting material into the chamber comprising a material collecting pipe rigidly carried by the kiln and adapted to rotate with the kiln, the pipe having a discharge mouth opening into the kiln, the pipe being located within the annular chamber, a valve located within the pipe, and means for opening the valve only at the time when the discharge mouth is adjacent its lowest position.

Shaking and screening apparatus. MILTON O. CEDERQUIST. U. S. 1,707,251, April 2, 1929. A shaking and screen apparatus including a plurality of oscillatory frames, each including oscillatory end members and a pair of cross bars extending between and connecting the end members at opposite sides of the axes of oscillation thereof, and grating bars having hooked depending extensions removably embracing the cross bars for support therefrom, some of the grating bars being connected with cross bars arranged at one side of the axes of oscillation of the frames and the remaining grating bars being connected with the other cross bars.

Drying rack. ROBERT V. PROCTOR. U. S. 1,708,588, April 9, 1929. A drying rack for ceramic articles comprising a hollow girder, a pair of spaced legs rigidly and permanently secured to the girder and upstanding therefrom to form an open top frame, and pallet holding means on the legs.

Sealing metal to glass. SIEMENS-REINIGER-VEIFA GES. FÜR MEDIZINISCHE TECHNIK. Brit. 303,348, Feb. 27, 1929. In sealed joints between metal and glass, the metal part at least at the point of sealing is an alloy of nickel and chromium, which contains preferably from 60 to 90% of nickel. The joint may comprise plates, tubes, or other parts sealed into, upon, or around glass, *e.g.*, in the manufacture of vacuum tubes.

Kilns, Furnaces, Fuels, and Combustion

Use of pulverized coal as a fuel for periodic kilns. D. J. WATSON. *Jour. Amer. Ceram. Soc.*, **12** [5], 336–41 (1929).—A research problem on the control of the temperature, using pulverized coal as a fuel for intermittent kilns. Operation and design of a fire box with a hot-spot combustion chamber for the ignition of the fuel during the water-smoking period, and first part of the oxidation period are described.

Stability and progress of the public utility fuel service. E. L. GATES. *Jour. Amer. Ceram. Soc.*, **12** [5], 342–46 (1929).—Because ceramic products require accurate control in all heating operations, natural gas has acquired a high rating as a fuel, but because of difficulties encountered such as exhaustion of supply, distant markets, etc., producer gas is more popular. City gas is available in all urban localities and therefore broadens the selection of location for any industry. The question of price of the city gas as compared with natural gas is dealt with and it is pointed out that the increase in recovery of by-products and efficiency of manufacture together with a steady decline of price of the utility fuel service since 1923 tends to lessen the difference in price between city and natural gas. Examples are cited where city gas is used for enamel smelting and brick firing successfully.

Coal. ANON. *Brick Clay Rec.*, **74** [7], 471–72(1929).—Coal, despite competition from oil, is still the most important fuel in the manufacture of clay products. A study of the cost of coal for firing the various types of ware gave the following results:

Type of ware	Per cent of total cost of manufacture	Coal used
Drain tile	29	450 lbs. per ton
Common brick	28	965 lbs. per M
Paving brick	24	2520 lbs. per M
Face brick	22	1320 lbs. per M
Hollow tile	20	450 lbs. per ton
Sewer pipe	18	1100 lbs. per ton
Refractories		1675 lbs. per M

General requirements for coal for firing clay ware are: (1) low sulphur content when used to fire ware in which color is important; (2) nonclinkering if used on grates; (3) hard, refractory clinker if used in dead bottom furnaces; (4) powdered or fine if used in continuous kilns; (5) long flame; and (6) high heat value. A recent study of the coal used in 150 typical clay plants shows the following kinds of coal being used:

	Per cent
Mine run	60
3/4 lump	20
Egg	14
Nut	6

Methods of cleaning coal, and sizing it are discussed. E.J.V.

Powdered coal firing clay products. W. C. HECKEROTH AND R. S. JULSRUD. *Brick Clay Rec.*, **74** [8], 531–33 (1929).—The Standard Clay Products Co., of Slidell, La., decided, due to the uncertain future price of oil they were then using, to experiment with pulverized coal to fire their kilns. A series of tests, using the "Warrior" direct fired system of pulverized coal to fire the ware, was conducted. This investigation had for its purpose the study of: (1) the proper setting of the ware to effect correct distribution of the gases in order to obtain uniform firing of the product; (2) the effect of ash upon the quality of the ware; and (3) the economical possibilities of pulverized coal in competition with fuel oil as kiln fuel. The equipment used in making four different firings during these tests, together with the firing location and setting of the ware for each firing are described in detail. Petroleum coke, used in one of the firings, is an ideal fuel for firing in pulverized form. Its advantageous features are pointed out. Data obtained in these experiments showed the requirements per M brick to be 571.2 lbs. of oil of 18,750 B.t.u. per pound compared with 845 lbs. of coal of 12,122 B.t.u. per lb. The cost was $2.14 for oil and $1.65 for coal, per M. brick. E.J.V.

Properties of coal in pulverized form. F. S. SINNATT. *Chem. and Ind.*, **48**, 268–69 (1929).—When coal is pulverized very finely, each particle may possess properties differing materially from the coal generally. This is due to the fact that coal seams are heterogeneous. Thus layers may differ from one another in yielding ash varying 200 to 400°C in melting point. Seams ground under uniform conditions do not pulverize in a uniform manner. The manner in which particles of coal burn affects combustion, since the particles of a coking coal may be converted into cenospheres before complete combustion takes place, and these may be carried into the atmosphere a considerable distance owing to their low specific gravity. H.H.S.

Pulverized coal application. E. H. TENNEY. *Blast Fur. Steel Plant*, **17** [3], 439–44 (1929).—In order to indicate the progress made with pulverized coal the operating records of a series of five different pulverized-fuel-firing arrangements and furnace designs have been assembled in such form as to show what value lies in each for this particular plant. These comparative values depend upon (1) grade and price of coal used, (2) plant load factor, and (3) rate for fixed charges. With these conditions the design best adapted shows a saving of $0.40 per ton coal in operating cost, and a saving of $2.44 in fixed charges. This result has been obtained by (1) reduction in coal-preparation costs, including the elimination of drying and transport equipment, (2) general improvement in boiler economy by development of the firing method best adapted to the fuel, (3) reduction in furnace maintenance by the use of water walls, (4) elimination of hard slag in furnace by horizontal firing, and (5) increase in ratings by the use of water walls, turbulent firing, and draft equipment. The last development has proved to be the most important in the matter of cost, and has been made possible by the experience with the other four developments. F.P.H.

Powdered coal and gas cleaning. ANON. *Iron Age*, **119** [20], 1443 (1927). A.J.M.

Smoke eradication. GEORGE A. BOLE. *Brick Clay Rec.*, **74** [7], 463–65 (1929).—Any kiln with a reasonable draft can be fired on high fire without producing smoke that will be considered a nuisance in any city. The problem is only one of following ordinary good firing practices and regulating the dampers and the doors in order to admit the requisite amount of air as needed and where needed. The use of a low volatile coal will

make the task easier but is not absolutely essential. The requisites for perfect combustion are: (1) sufficient air to furnish the required amount of oxygen to complete the combustion; (2) an intimate mixing of the combustible and the air turbulence; (3) the mixture of air and combustibles must be brought together at a temperature above the ignition temperature of the combustible. The action of air in the fuel bed is discussed. Three general methods of firing coal are: (1) Covering the entire fuel bed with green coal is called the "ordinary method." (2) Covering half of the bed with green coal at alternate stokings is called the "alternate method." A modification of the alternate method in the case of ceramic kilns is to fire the furnaces alternately. (3) Shoving back or to one side, the incandescent bed and stoking the green coal on the clean grate bars, is called the "coking method." These methods of firing are discussed separately. The use of low volatile fuel is also taken up. E.J.V.

Alabama coals. ANON. *Cement, Mill, and Quarry*, **34** [4], 29 (1929).—In a general investigation for the improvement of coal-washing practice in Ala., a specific gravity study of the coals has been made by the Department of Commerce, in coöperation with the School of Mines of the Univ. of Ala. In recent years, the production of coal in Ala. has been at the rate of approximately 20,000,000 T. annually. Although exact figures are not available as to the tonnage being handled by the coal-washing plants, it is probable that at least 60% of the coal production is shipped out from the washing plants as washed coal. About 30% of the coal produced in 1926 was used in the manufacture of coke. Metallurgical coke should contain a minimum amount of ash and sulphur and it was found in Ala. that, as a general rule, Ala. coals were too high in ash to produce a satisfactory coke, unless they were washed before coking. Analyses of Ala. coals, it was found, show a considerable variation in percentage of ash, but a rather limited variation in percentages of moisture. About 85% of the samples of coal studied during this investigation ranged between 2 and 15% ash content. The moisture content of the samples was rarely higher than 4.5% or lower than 2%. The specific gravity determinations which were made indicate that samples which contain from 2 to 15% ash have specific gravities which vary approximately from 1.26 to 1.37. Ordinarily, the specific gravity values increase quite uniformly as the percentages of ash increase. A few samples were studied whose ash contents were 20% or higher. Their specific gravities were found to be about 1.42 or higher. A sample, the analysis of which showed 51.5% ash, was found to have specific gravity of 1.80. E.P.R.

U-tube manometer. ANON. *Cement, Mill, and Quarry*, **34** [4], 68 (1929).—One of the simplest forms of instruments for measuring pressure, vacuum and flow of gases and liquids, draft pressures, etc., is the ordinary U-tube manometer. Essentially it consists of a suitable length of glass tube bent in the form of a U, the ends being connected to the two points between which is the difference of pressure, etc., required to be measured. The total difference between the levels of the liquid in the two arms shows the difference in pressure conditions between the two points to be tested, and a suitable scale set beneath the tube permits direct readings being taken. E.P.R.

Clay firing. W. MIEHR. *Refract. Jour.*, **4** [42], 184 (1929); for abstract see *Ceram. Abs.*, **7** [11], 788 (1928). E.P.R.

Low temperature carbonization plant. ANON. *Blast Fur. Steel Plant*, **17** [4], 576–78 (1929).—The new plant of the International Coal Carbonization Co. near New Brunswick, N. J., is unique in the whole history of coal-processing. In a single operation it transforms cheap bituminous slack coal into a smokeless domestic fuel superior to anthracite, and at the same time recovers gas, tar, and light oil (motor fuel) in their most valuable forms. Methods and processes are given. With an annual carbonizing capacity of 250,000 T., this plant is the largest low-temperature carbonization enterprise in the world. F.P.H.

Industrial use of fuel oil. ANON. *Iron Age*, **119** [6], 446 (1927). A.J.M.

Oil, gas, and electric furnaces. F. W. MANKER. *Iron Age*, **120** [12], 789 (1927). A.J.M.

Fuels: past, present, and prospective. S. W. PARR. *Iron Age*, **120** [16], 1077 (1927).—Fuels used for the past century are discussed. Gaseous fuels are favored as being ideal. A.J.M.

Relative industrial furnace economies. C. L. IPSEN AND A. N. OTIS. *Iron Age*, **120** [15], 1005 (1927). A.J.M.

Fuel briquets. ANON. *Iron Age*, **119** [15], 1082 (1927).—Production of briquets of fuel in 1926 was 995,332 net tons, valued at $8,533,179. This compares with 839,370 T. in 1925 at a value of $7,128,404. Production has been growing ever since the first statistical survey, in 1907, showed a total of 66,524 T. A.J.M.

Electric furnace for the firing of ceramic ware. MAURIZIO KORACH. *Corriere ceram.*, **9**, 495-97 (1928).—K. emphasizes the value of electric furnaces in the ceramic industry. He gives a detailed description of an electric furnace built by the firm Scei (Novara). (*C.A.*)

Theoretical considerations in electric tunnel kiln design. J. KELLEHER. *Trans. Amer. Electrochem. Soc.*, **55**, preprint, 5 pp. (1929).—The variables in electric tunnel kiln design, and the order in which they are determined are: (1) time-temperature curve for the material; (2) most economical cross-section; (3) velocity; (4) length; (5) rate of energy absorption (in each section); (6) furnace temperature (in each section); (7) losses (in each section); and (8) heat input (in each section). A general set of curves is given, but neither details nor an example of the calculations is included. (*C.A.*)

Electric furnaces in the ceramic industries. S. R. HIND. *World Power*, **10**, 599 (1928).—The present status of the application of electric heat to ceramic practice is reviewed. The characteristics of ceramic heat treatments are described with the aid of heating curves. In a firing enamel a normal coal-fired muffle requires 19 hrs. to give satisfactory results. With electric furnace better results can be obtained in half the time. Features favorable to the electric kiln are: (1) purity of furnace atmosphere; (2) good temperature control; (3) elimination of muffles; (4) economy of capital due to use of small unit furnaces and rapid output of ware; (5) constant load factor in continuous electric tunnel-type kiln; (6) high availability of energy compared with fuels; (7) minimum labor charges. In the tunnel kiln of Campbell and Moore, used for decorated ware, Ni-Cr heating elements are used. The hottest zone is near the middle of the tunnel, which is kept full of trucks of ware at all times. The maintenance cost ratio, per kiln dozen of ware, in electric vs. coal is $\frac{1}{2}$ d. to $1\frac{1}{2}$ d. The overall cost showed a saving in favor of electric heating. The Morgan electric kilns are designed with special graphite ceramic resistors for lengths up to 60 ft. The Harper kiln is 68 ft. long equipped with 30 kw. looped wire in the 24 ft. preheating zone and 60 kw. Acheson graphite plate in the hot zone. Details of tests on this furnace are awaited. (*C.A.*)

PATENTS

Tunnel kiln. WILLIAM LEE HANLEY, JR. U. S. 1,705,475, March 19, 1929. A tunnel kiln comprising among its members a firing zone, provided with heating means discharging their products of combustion into the firing zone, a preheating zone extending longitudinally from one end of the firing zone, a cooling zone extending longitudinally from the other end of the firing zone, goods conveying means extending through all of the zones, means for withdrawing the products of combustion from the firing zone without permitting appreciable longitudinal flow thereof and means for conducting them outside of the kiln into the preheating zone for preheating, water-smoking, and oxidizing the unfired products therein.

Tunnel kiln. WILLIAM LEE HANLEY, JR. U. S. 1,705,477, March 19, 1929. A single tunnel kiln, comprising among its members a centrally located firing zone, provided with a series of furnaces discharging their products of combustion into the firing zone, means for withdrawing the products of combustion directly from the firing zone without permitting appreciable longitudinal flow, a preheating zone extending longitudinally from one end of the firing zone, a cooling zone extending longitudinally from the other end of the firing zone, a single line of goods conveying means extending through all of the zones, means for supplying air from the outside of the kiln to the cooling zone for heating it from the hot fired products therein, and means for withdrawing the heated air from the cooling zone and discharging it into the preheating zone for preheating, oxidizing and water-smoking the unfired products therein.

Continuous ceramic furnace. JOSEPH A. DEDOUCH. U. S. 1,708,083, April 9, 1929. In combination, a ceramic furnace having a horizontal heating chamber, continuous integral parallel conveyer elements passing through the chamber, and means in the chamber for supporting and propelling the conveyer elements.

Continuous ceramic furnace. JOSEPH A. DEDOUCH. U. S. 1,708,124, April 9, 1929. In combination, a ceramic furnace having a heating chamber, and parallel conveyer elements, having a flat cross-section, the long axis of the section being vertical, movable through the heating chamber at substantially the same speed for carrying objects to be fired.

Tunnel kilns. H. M. ROBERTSON. Brit. 305,025, March 27, 1929. In a tunnel kiln, having along each side of the firing zone a combustion chamber in communication with a series of fire boxes burning solid or pulverized fuel, each combustion chamber is extended downwardly to form a settling-space from which the dust, etc., deposited from the gases may be removed through ports. The latter are disposed at each end of a space and communicate with re-entrant bays which provide space for the manipulation of the steam, air, or the like, pressure or suction apparatus used for removing the collected dust. The combustion chambers are provided with perforated walls for the passage of the hot gases into the kiln and are covered at their upper ends by slabs having spaced vertical baffles. The tunnel itself is formed with outer and inner walls separated by a layer of heat-insulating material, which latter is covered at the top by a block abutting against the pediments supporting the arch; the entire upper surface of the kiln between the outer walls is covered with heat-insulating material.

Geology

An investigation of twenty-one Saskatchewan ball clays. W. G. WORCESTER. *Jour. Amer. Ceram. Soc.*, **12** [5], 360–76 (1929).—Twenty-one Saskatchewan ball clays have been investigated; the study covers in a general way their chemical, raw, and fired properties. The information presented will no doubt prove of immediate interest to the ball clay trade and especially to the Saskatchewan shippers and exporters. In general the more outstanding properties of the clays studied are raw strength, fired color, craze resistance, and rate of vitrification. Their raw strength is remarkably high, greater than that of any similar clay on the market at the present time. One clay developed the exceptional raw strength, though diluted with 50% potters' flint, of over 1000 lbs. per square in., a second one 938 lbs., while the average of the eleven highest is 812.8 lbs.; clays of such high strength should prove of interst to the trade where it is desirable to reduce losses in the raw and bisque state. A number of the clays tested are outstanding as ball clays in that they fire white or nearly so up to and including cone 12, the purity of whiteness being equal to that of white firing china clays. The porosity and fired volume shrinkage of the Saskatchewan clays correspond more nearly to those of the English ball clays than do the Tenn.-Ky. clays as studied by Sortwell.

Barite and barium products in 1927. R. M. SANTMYERS. Bur. Mines, *Mineral Resources of the U.S.*, Part II, pp. 247–56 (1928).—The barite industry in the U.S. apparently prospered during 1927, as sales of almost all of the products showed an advance over the previous year. The quantity of crude barite sold or used by producers during 1927 was the largest ever recorded, exceeding that of 1926 by 16,390 T. or 7%. The average value of sales in 1927, however, was the lowest since the war. During the year 1,670,878 short tons of material was sold at $6.57 per T. The publication describes consumption by uses and stocks on hand as of Dec., 1927. The total imports of barite during 1927 was 70,274 short tons valued at $253,284. Tables are given on world production, and barium products, *i.e.*, refined ground barite and lithopone. A list of producers is appended. R.A.H.

Mineralogy of the potash fields of New Mexico and Texas. WALDEMAR T. SCHALLER AND EDWARD P. HENDERSON. *Min. and Met.*, **10** [268], 197–98 (1929).—The material available for mineralogic study consisted of drill cores, 2 to 3 in. thick, supplemented by small well cuttings. Such study has added no essential new information regarding the minerals, though the refractive indices, used for determinative purposes, have been determined more accurately than before, permitting the development of a scheme for the rapid identification of these minerals. The essential points brought out by the investigation are two: (1) that certain mineral associations evidently point the way to an understanding of the geologic history and (2) that a definite sequence of mineral formation has taken place so that the original minerals formed have been in part reacted on producing new compounds and associations. A typical and repeated association is clay at the bottom followed by anhydrite or polyhalite, above which is a mixture of polyhalite and halite. Above this is nearly pure halite. Such associations as clay and magnesite, anhydrite and magnesite, and anhydrite magnesite and polyhalite, halite, and polyhalite, halite and sylvite, are very common. Much of the anhydrite and polyhalite is banded due to layers of magnesite and to a lesser degree to clay. The halite and the sylvinite (mixture of halite and sylvite) is not banded. F.P.H.

Potash from New Jersey greensand. J. R. THOENEN. Bur. Mines, *Rept. of Invest.*, Serial No. 2910, 53 pp. (Feb., 1929); *Cement, Mill, and Quarry*, **34** [3], 68 (1929).—The purpose of this preliminary study was to investigate existing literature and previous investigations to ascertain the extent and availability of the deposits, the extent of commercial success so far attained in potash extraction, the most promising known methods and by-products obtained from them, probable markets and possibility of competition with foreign potash, and by a study of these data to determine whether further chemical engineering analysis and laboratory investigation were warranted. The N. J. greensand marl beds outcrop over a long and comparatively narrow area extending entirely across the state from Perth Amboy and Sandy Hook on the Atlantic coast to Salem on the Delaware River. In spite of the fact that vast tonnages of glauconitic marls are available for easy mining there is at present no large scale successful process in operation for the extraction of potash therefrom. The present study indicates that foreign potash fertilizer products can be distributed at seaboard and in interior points at lower freight rates than similar products from N.J., and also that further laboratory studies of extraction processes are required. R.A.H.

Valuable clay in Arkansas. ANON. *Clay-Worker*, **91** [4], 324 (1929).—The discovery of kaolin and other valuable clays southwest of Jonesboro, Ark., Craighead County, along the Cotton Belt R. R., has recently attracted considerable interest in Arkansas. Chinaware can be produced from this clay. In the section around Benton, Ark., and a few other towns in the state, splendid pottery clays are found and pottery products are manufactured. Geological maps show that the entire peak of Crowley's

Ridge is underlaid with clay that varies in grade from good ironware material to finest kaolin. E.J.V.

Clay deposit. ANON. *Brick Clay Rec.*, **74** [8], 552–54 (1929).—A grade of clay found near Pleasant Hill, Ill., in Calhoun County, is said to be good for the manufacture of ceramic products. It is light color when fired, shows a fusion at 3218°F, and excellent results have been obtained in its behavior in drying and firing. Recent drilling has revealed a vein of high-grade clay 7 to 9 ft. thick over an area of more than 20 acres. E.J.V.

Nature and uses of fluorspar. ANON. *Cement, Mill, and Quarry*, **33** [4], 26 (1928).—Fluorspar, or fluorite, is a nonmetallic crystalline mineral occurring in glassy, transparent isometric crystals, largely cubic, or in cleavable masses. Less commonly it has a granular or fibrous structure, and occasionally it is banded. Fluorspar has a specific gravity of 3.2, is brittle, has a hardness of 4, and can easily be scratched with a knife. Fluorspar is a mineral of many colors, ranging from clear, colorless, or slightly bluish, and glasslike, through various striking hues, of which purple and green are most common; much of it is white and opaque. Chemically it consists of calcium and fluorine in the proportion of 51.1 to 48.9. Fluorspar has many uses, but its most important use is in the manufacture of steel by the basic open-hearth process. It is also used in the manufacture of alloy steel and ferro-alloys by the electric furnace process, and in some foundry and other metallurgical operations. Fluorspar is used in considerable quantities in the glass industry, chiefly for the manufacture of opaque and colored glass; as an ingredient in enamels for various purposes; and in the manufacture of cement, in which it is said that the addition of fluorspar to the raw materials permits the lowering of the fusing point, resulting in economy in fuel, as well as an economy in power, because the clinker obtained is fragile and therefore more easily ground. Fluorspar is the basic material used in the manufacture of hydrofluoric acid. It is also said to be used to facilitate the fusion and contact of ingredients in the manufacture of calcium carbide and cyanamide. A very small quantity of clear fluorspar is used for optical purposes; fluorspar is useful in correcting the color and spherical aberration errors in lenses, especially for microscopes and small telescopes. E.P.R.

Feldspar deposits in South Dakota. ANON. *Eng. Min. Jour.*, **124** [16], 626 (1927). A.J.M.

Feldspar in Ontario. ANON. *Can. Chem. Met.*, **13** [3], 21 (1929).—During 1928, eight producers shipped 18,864 T. valued at $79,253 compared with 17,119 T. worth $154,533 in 1927. The major part of Ontario's feldspar is exported in the crude state to the U.S. for use mainly in the pottery trade. This material is generally ground so that 91% will pass a 330-mesh screen. A market which offers future expansion in the consumption of feldspar is in the manufacture of certain cheaper grades of glass. Feldspar for this purpose is ground to 40-mesh, and is usually sold on the basis of combined alkali and alumina content. E.J.V.

Preparation and uses of feldspar. ANON. *Cement, Mill, and Quarry*, **33** [4], 59 (1928).—The uses of feldspar are manifold. Its principal use is as a flux in the pottery, glass, and enameling industries, including tiles, porcelains, and so-called marbles that find their use in hotels and other places where a vitrified surface is desired for sanitary reasons. It is also used as an abrasive in scouring soap, and as a binder in the manufacture of abrasive wheels. Efforts to use feldspar as a source of supply of potash on a commercial scale continue, but claims of success remain unestablished. E.P.R.

Feldspar and graphite in Quebec. R. C. ROWE. *Eng. Min. Jour.*, **124** [23], 893–95 (1927). A.J.M.

Uses of graphite in the industries. ANON. *Cement, Mill, and Quarry*, **33** [4], 61

(1928).—Natural graphite is used chiefly in the manufacture of foundry facings, pigments and paints, crucibles, etc. E.P.R.

Asbestos and the Arizona industry. C. TRISCHKA. *Eng. Min. Jour.*, **124** [9], 337–40 (1927).—T. discusses in detail the mineralogy, geology, and mining of asbestos. A.J.M.

Geological features of Washington magnesite deposits. S. S. SIEGFUS. *Eng. Min. Jour.*, **124** [22], 853 (1927).—The magnesite deposits of Stevens County, Wash., are probably the largest source of magnesite in N. America. They are on the east side of the Huckleberry Mts., about 60 mi. north of Spokane. The deposits were first worked for magnesite in 1916. The variety in Wash. is of a coarse crystalline texture and occurs as massive bedded deposits of dolomite. It is light gray in color, although some is reddish brown. In the more crystalline rocks it has generally been found that the coarser the texture is, the higher the lime. There are no general rules for recognizing the different grades by sight. The ore is about 94% pure magnesium carbonate. The following classification for the different grades has been suggested.

	Limits	
Grade	SiO_2 (%)	CaO (%)
High grade	Under 1	Under 1
Good ore	1 to 3	1 to 2
Fair lime	Under 2	1 to 3
Fair silica	1 to 4	Under 2
Poor silica	Over 4	
Poor lime		Over 3

Rough estimates place the total reserve at from 5 to 7 million tons. The magnesite deposits of Wash. as well as those of Austria and Quebec have been ascribed to the class occurring as a replacement of limestone and dolomite. In this class the magnesite occurs as a replacement of limestone or dolomite through the agency of magnesia-bearing solutions of magmatic origin. The Wash. deposits, however, have many distinctly sedimentary features. S. supports the theory that the magnesite was deposited directly and contemporaneously as magnesium carbonate. A.J.M.

Nonmetallic activity in North Carolina. H. J. BRYAN. *Pit and Quarry*, **17** [13], 81 (1929).—1928 mining and quarrying conditions, particularly kaolin, feldspar, mica, and flint productions are discussed. One of the chief developments in the kaolin industry was the introduction of a new process of washing. Clays produced by this method are said to be superior to those by other methods. A new process for the recovery of scrap mica has also been evolved. In the past two years, the grinding capacity of feldspar mills has been increased from 180 to 410 T. daily. Production of feldspar for 1928 in N.C. is estimated at 70% of that of the entire country. N.C. has been the chief mica producing state for years. Foreign competition now threatens this leadership. Quartz and flint production has been steadily increasing and could be still further developed if more whiteware plants would locate there. R.G.E.

Georgia's mineral resources. ANON. *Cement, Mill, and Quarry*, **34** [4], 36 (1929).—State Geologist McCallie of Ga. records the development of mineral resources as compiled by the State Geological Survey with the coöperation of the U. S. Geological Survey and the Bureau of Mines. The total output of the year amounted to $18,568,055, a decrease of $584,848 as compared to 1926. E.P.R.

Illinois mineral deposits. ANON. *Cement, Mill, and Quarry*, **34** [4], 59 (1929).—More than 900 deposits classed as mineral are worked in Ill. and the output is more than $1,000,000 for each working day. Among the leading minerals produced are coal, petroleum, clays, building stone, lead, zinc, fluorspar, tripoli, fullers' earth, sand, and cement. E.P.R.

Canadian clay-belt survey. W. M. TOBEY. *Can. Eng.*, **56,** 395–96 (1929).—The work of the Canadian Geodetic Survey for the year includes the geodetic control of the northern part of Ontario, starting from the end of their triangulation near Iroquois Falls and wending westward to Cochrane. The country is very flat, and constitutes the clay belt. The members of the Survey are also investigating isostasy at 100 stations across Canada. H.H.S.

Antimony industry in New Brunswick. A. D. TAYLOR. *Can. Machinery,* **40** [7], 74 (1929).—The Lake George Mines, Ltd., of which T. is president, are installing a plant for Sb in New Brunswick. It will be in operation in Aug. H.H.S.

Chilean nitrate output. ANON. *Chem. and Ind.*, **48,** 272 (1929).—The output in 1928 was 3,163,000 metric tons, which is 100,000, more than the record output brought about in 1917 by war demands. World stocks at the end of 1928 were estimated at 2,133,200 metric tons. H.H.S.

Imitation gem-stones determination. F. A. BANNISTER. *Chem. News,* **138,** 175 (1929).—Paper delivered to the Mineralogical Society of London in March. H.H.S.

Wind-blown dust. KIDSON. *Morning Post,* March 14, 1929.—K., who is Dominion Meteorologist of New Zealand, states that many tons of soil from Central Australia were precipitated by rain on the southern parts of New Zealand after a journey of 2000 mi., mostly over water. The concentration in the atmosphere was so great that the rain was described as sand-rain. Similar occurrences have been recorded from the Atlantic to the west of the Sahara. H.H.S.

Thomas Chrowder Chamberlin obituary. BAILEY WILLIS. *Sci. Monthly,* **28,** 89–91 (1929).—An appreciation of the author of the planetesimal hypothesis of the earth's origin. H.H.S.

Geologic exploration in Central Asia. C. P. BERKEY. *Sci. Monthly,* **28,** 193–216 (1929).—The Central Asiatic expeditions (to the Desert of Gobi and other places) have made two notable contributions to geology. The first is the classification of formations and the mapping of rock units; the second, the interpretation of the accumulating mass of data in terms of processes and origin. H.H.S.

Kaolin production of North Carolina. J. L. STUCKEY. *Ceram. Age,* **12** [3], 85–89 (1928).—S. gives a brief review of the occurrence, distribution and mining of kaolins in N.C. True kaolins are considered to be white, residual clays which are refractory, low in plasticity, white and open firing. The term is not properly applied to the so-called plastic kaolins which are sedimentary. Most kaolins contain considerable impurities, especially quartz and often mica. Their fineness determines the ease of washing. Kaolin deposits are rather widely distributed in eastern U.S. N.C. is the chief producer of true kaolin in the U.S. The 1926 production was 20,719 T., valued at $331,487. The deposits were formed from (1) pegmatite dikes, (2) granites, (3) schistose rocks. Most of the mountain district deposits were formed in pegmatite masses. N.C. falls into three natural divisions: the coastal plain, piedmont plateau, and Appalachian Mountain area. The last named area contains the important commercial deposits which are found in Mitchell and Yancey Counties. Three companies are operating 8 or 9 mines and producing about 20,000 T. of finished kaolin annually. Prospecting must be thorough. Mining is done entirely by the open cut method. From the flume, the crude kaolin passes through beaters and sand troughs and is then screened, filter-pressed, and dried. Recent improvements include classifiers, and mechanical units that replace the sand troughs. The prepared kaolins are used for china, semiporcelain, porcelain, mosaic tile, and spark plugs. Several tons of "ground mica" daily are secured as by-products. Reserves of kaolin appear to be more than 650,000 T.

A.E.R.W.

Dispersion of minerals. A. N. WINCHELL. *Amer. Mineral.*, **14** [4], 125 (1929).—The new methods of studying powdered minerals lead naturally, not only to a knowledge of their indices of refraction in ordinary light, but also and simultaneously to a knowledge of the variation in their indices with variation in the wave-length (or color) of light; *i.e.*, the new methods lead to a knowledge of the dispersion of minerals. The dispersion of a mineral is as definite a physical property as its refringence or birefringence and may be used to identify it. At present, data regarding the dispersion of minerals are remarkably few and in some cases not very accurate. All available data on dispersion (of reasonable accuracy) are assembled in the tables given. In order to make these data useful for determinative purposes, the minerals are classified first in groups of increasing dispersion, and then arranged in each group in the order of increasing refringence. The dispersion given is always the difference between the index in light of 4861 Å wave-length (= the Frauenhofer line *F* or the β line of hydrogen) and the index in light of 6563 Å wave-length (= the Frauenhofer line *C* or the α line of hydrogen). In the tables this dispersion is meant by the expression *F-C*. In anisotropic crystals the dispersion of the substance is, in general, not the same for light vibrating in directions which are crystallographically unlike. Therefore, the dispersion for N_g is not the same as for N_p, and the dispersion for N_m is not equal to that for N_g or to that for N_p. These differences, however, are usually small, and the only dispersion given in the table is that for N of isotropic substances, N_o of uniaxial substances and N_m of biaxial substances (with rare exceptions, in cases where data are not available for N_m). F.P.H.

BOOKS

Soil Mineralogy. FREDERICK A. BURT. Illustrated. D. Van Nostrand Co., New York, 1927. Reviewed in *Amer. Mineral.*, **14** [4], 163 (1929).—This is an elementary text for students of soils. The introductory chapters deal with the physical properties of minerals, the elements of soil minerals, and general principles covering the weathering of minerals. The major portion of the text is devoted to a description of 66 minerals which occur in soils. Short tables are included to illustrate the relative weathering resistance and volume changes of minerals during alteration, and for the determination of minerals. F.P.H.

Microscopic Characters of Minerals and Rocks. H. ROSENBUSCH. Vol. 1, 2nd half, 5th. ed. enlarged and revised by O. MUGGE. Pp. xvi + 814, illustrated. E. Schweizerbart, Stuttgart. Reviewed in *Amer. Mineral.*, **14** [4], 161 (1929).—This work is a very complete account of the microscopic characters of the rock-forming minerals. Minerals are described in the order of decreasing symmetry of the crystal systems to which they belong, while the order within each crystal system follows Groth's chemical classification. M. has revised the fourth edition and also added greatly to the value of the work by more complete descriptions of the modes of occurrence of minerals and some discussions of their physico-chemical relations. Bibliographies follow each descriptive unit. F.P.H.

Tin: Salient Facts and Opinions. J. A. L. GALLARD AND M. STUART. Mining Publications, London, 1929. Price 2*s* 6*d*.—Covers the subject from geology and mining to costs and statistics. H.H.S.

PATENT

Locating geological formations. JOHN CLARENCE KARCHER. U. S. 1,706,066, March 19, 1929. In a system for locating subsurface formations, a source of radio frequency waves, means for producing mechanical impulses through the air and through the ground, means for causing the simultaneous transmission of the radio frequency waves and the mechanical impulses, means for receiving and recording the radio frequency waves at a point distant from that of transmission, means for receiving the mechanical impulses at the same point, and means for separately recording the time

of arrival of the mechanical impulses through the air and the direct and diffracted impulses resulting from the mechanical impulse through the ground.

Chemistry and Physics

Rate of drying of a plastic porcelain mass due to reduced pressure and heat. LOUIS NAVIAS. *Jour. Amer. Ceram. Soc.*, **12** [5], 305–18 (1929).—Experiments in drying plastic porcelain masses are performed using reduced pressures of 0.7, 5, 15, and 35 cm., with surrounding temperatures of 23, 50, and 65°C. Plotting the logarithm of the loss of weight against the logarithm of time, straight-line relationships are found to exist for the drying rate. With the lowest pressure a single slope is found, whereas with the three higher pressures, there are two slopes to each curve. The lowering of the temperature of the whole mass with lowering in pressure is shown. Effect of shape of specimen and humidity of air on rate of drying is discussed.

Prediction of service value from laboratory test data. A. E. R. WESTMAN. *Jour. Amer. Ceram. Soc.*, **12** [5], 319–29 (1929).—Accurate prediction of service value is a prerequisite to the devising of methods of control, development, and specifications based on laboratory test data. The precision conditions which must be met before such prediction is possible are given in the paper and the difficulties usually encountered in trying to meet these conditions in ceramic work are shown by examples chosen from the field of refractories.

Plasticity of clay. W. MIEHR, H. IMMKE AND J. KRATZERT. *Sprechsaal*, **61** [17], 319–21 (1928).—Two views held at present as to the cause of plasticity of clay are (1) it is due to chemical reactions which occur between the clay and certain impurities and (2) it is a physical reaction which is the cause of that condition. The authors discuss a theory which they have developed based on the second assumption. R.A.H.

Plasticity of clays. GUSTAV KEPPELER. *Keram. Rund.*, **35**, 157–58 (1927).—Colloidal properties of clays are discussed. Clays depend not only upon fineness of grain for their plasticity, since quartz ground to the same fineness is much less plastic, but also upon the shape and nature of the grains. The platy character of the crystals probably has a marked effect on the plasticity. H.I.

Plasticity of lime. KENNETH W. RAY AND FRANK C. MATHERS. *Rock Prod.*, **32** [6], 60–62 (1929).—It is shown that most putties contain particles having positive electrical charges and, therefore, those particles are attracted by any outside negative electrical charge. The amount of this attraction or cataphoresis is greatest for plastic putties and least for nonplastic putties. The theory is developed that plastic hydrates owe their plastic properties to their power of forming charged particles upon soaking or slaking. It is shown from the theory of Donnan that the charged particles hold around them a film of solution, which so lubricates the particles as to make the putty plastic or easy to spread with a trowel. F.P.H.

Determination of crystallographic constants in the triclinic system. A. L. PARSONS. *Amer. Mineral.*, **14** [4], 154 (1929).—A modification of the calculations offers many advantages in relating all the constants directly to two circle measurements. The purpose of this paper is to demonstrate a simple method of calculating the angular and linear constants of a triclinic crystal from measurements on the two circle goniometer. F.P.H.

Progress in crystallography. W. L. BRAGG, R. W. JAMES, J. D. BERNAL, AND A. J. BRADLEY. *Ann. Rept. Chem. Soc.*, **25**, 275–302 (1929).—Progress in the study of crystal structure is described under the headings inorganic, organic, and alloys. Sillimanite, mullite, the feldspars, and other silicates are discussed, and Machatschki's classification of silicates into ortho-, meta-, and feldspar types, is given. The task of crystal physics is to link up the known properties of real crystals with their structures as de-

termined from X-ray measurements. The quantitative agreement between calculated and observed values is at present poor, owing to the fact that the theorist deals with an ideally regular crystal lattice which does not as a rule occur in nature even in single crystals. Crystal growth is a subject cognate with crystal perfection. H.H.S.

Apparatus for rapid sedimentation analysis. C. J. VAN NIEUWENBURG AND W. SCHOUTENS. *Ber. deut. keram. Ges.*, **10** [1], 2–6 (1929). See *Ceram. Abs.*, **7** [10], 703 (1928). F.P.H.

Barium oxide and blast-furnace slags. C. E. WOOD AND T. L. JOSEPH. *Blast Fur. Steel Plant*, **17** [4], 548–54 (1929).—The experimental data obtained indicate that: (1) The addition of sufficient quantities of barium hydrate to slag of normal composition to introduce up to 5% BaO into the slag does not markedly increase the desulphurizing action of the slag. Such an addition of BaO produces a small increase in the molar basicity of the slag and in its desulphurizing action. (2) A replacement of SiO_2 by BaO increases the molar basicity of slag and therefore its desulphurizing action. A replacement of equal percentages of CaO by BaO decreases the molar basicity of the slag and its desulphurizing action. F.P.H.

Chemical and petrographic composition of slag. ANON. *Pit and Quarry*, **17** [13], 72 (1929).—The National Slag Assn., Cleveland, Ohio, has published several symposiums on the characteristics and uses of blast-furnace slags. No. 11 discusses the components of blast-furnace slag and gives tables taken from reliable sources to make public many analyses of the product. The symposium contains 20 tables of analyses which give the conclusions of the different authorities. The quality of slag produced at any one works, where the same description of iron is being manufactured from one uniform type, varies within very narrow limits. In American blast-furnace slags the principal components are silica, alumina, lime, and magnesia, with small quantities of manganese, iron, and sulphur, none of which occur in the free state but in combination with other elements. The average analysis of 269 samples shows the following values in per cent: SiO_2, 36.25; Al_2O_3, 13.04; MnO, 0.79; FeO, 0.91; CaO, 40.60; MgO, 6.37; and sulphur compounds, 1.53. R.G.E.

Analytical balance for high temperatures. TAKAYUKI SOMIYA. *Jour. Soc. Chem. Ind., Japan*, **32** [3], 75–76B (1929).—The kinds of balance used to study the physical and chemical changes at high temperatures, *e.g.*, volume change of metals, alloys, etc., specific gravity of metals, alloys, and salts in fused states, decomposition and combination of the compounds, are as follows: (1) the Westphal balance, (2) ordinary chemical balance, (3) thermobalance, and (4) micro- and semimicrobalance. The sensitivities of these balances are not good enough to be used for accurate measurements, therefore, the author studied the making of a new and simple balance by which one is able to weigh continuously and accurately to 0.1 mg., keeping the pointer of the balance always on the zero mark, even when the body is heated to high temperatures and its weight changes with the time. A figure shows the balance set up in connection with an electric furnace and its manipulation is explained. As an example the author took pure calcite in the crucible on the balance and traced its decomposition by means of the balance. The loss in weight between 200 and 800 to 900°C is shown in the table, almost coinciding with the amount of carbon dioxide calculated from the formula weight.

Sample	Calcite (g.)	Calcite (g.)	$CaCO_3$ (Kahlbaum, for analysis) (g.)
	0.3039	0.3028	0.3079
CO_2 (exp.)	0.1336	0.1331	0.1355
CO_2 (calcd.)	0.1336	0.1331	0.1354

E.J.V.

Chemical action of lime upon siliceous material and trass. P. MECKE. *Tonind. Ztg.*, **52** [74], 1498–99 (1928); *Rock Prod.*, **32** [6], 94–95 (1929).—M. analyzes the com-

position of Si material and also of trass; discusses the incompleteness of determining the soda-soluble acid and suggests in its place the determination of the quantity of baryte fixed by the Si material; describes the physical and chemical action of lime upon Si material and the determination of increases in temperature when mixing lime with Si material; discusses the solubility of Si material and trass in hydrochloric acid solutions; and the influence of carbonic acid as well as solubility in soda solution and caustic potash solution. F.P.H.

Progress in general and physical chemistry. HAROLD HUNTER. *Ann. Rept. Chem. Soc.*, **25,** 11–36 (1929).—Topics selected as having been brought into prominence during the past year are infra-red spectroscopy, rotatory dispersion, the law of mass action, cohesion of solids (under which glass is considered as a fourth state of matter, since it has the heat capacity of a solid but random arrangement of its units like a liquid), oxide films on metals, and electrode potentials. H.H.S.

Progress in inorganic chemistry. H. V. A. BRISCOE AND P. L. ROBINSON. *Ann. Rept. Chem. Soc.*, **25,** 36–66 (1929).—Subjects of special interest are: (1) halides, HgHe or $HgHe_2$ having been synthesized, (2) the chemical evidence that Cs and Ti are not "simple" elements, but mixtures of isotopes, (3) the evidence that the heavier isotope of K is responsible for its radio-activity, (4) the reactions of Be (Gl) and its salts in liquid NH_3, (5) a full investigation of calcium nitrides, which depend for their color on their temperature of formation, (6) a new classification of the rare earths by J. F. Spencer from solubility data and magnetic ionic moments, (7) silicic acid and the silicates, the mono- and di-silicate anions only being present in solutions, (8) Ge compounds, including GeF_4 which rapidly etches glass but not quartz below 700°, (9) NF_3, a remarkably stable gas, (10) compounds of S and of Se, (11) the chemical properties of rhenium. H.H.S.

Progress in analytical chemistry. B. A. ELLIS AND J. J. FOX. *Ann. Rept. Chem. Soc.*, **25,** 198–221 (1929).—Definite advances in analytical practice are recorded. Microchemical tests for various elements, particularly Ga, In, Rb, are now attaining importance. The separation of Ta and Nb (Cb) is effected by the tannic acid method, and Be (Gl) may be separated from Al and Fe by 8-hydroxyquinoline in acetic acid solution. Many papers dealing with potentiometric methods have appeared, and the ease of using the method in practice has been demonstrated. Ceric sulphate in acid solutions is a useful agent in potentiometric work, as in the determination of V in steel and of nitrites and peroxides among other substances. Tungsten has been found useful as a "reference" electrode. Qualitative and quantitative advances in inorganic, organic, and physical chemistry are outlined. Of ceramic interest are the determination of ferrous iron in silicate rocks, the reddish violet color of Mg salts with an alcoholic solution of diphenylcarbazide, color reactions of Co, Ni, Zn, Al, etc., the estimation of Cd by pyridine and thiocyanate, and the microchemical determination of phosphoric acid as strychnine phosphomolybdate. H.H.S.

Physics in industry as a career. R. W. KING. *Sci. Monthly*, **28,** 225–31 (1929).—K. emphasizes the difference between the physicist in industry and physics in industry, and urges their coöperation. Several leading industries have recognized their indebtedness to pure science by large contributions to the National Academy fund. H.H.S.

Action of silica and alumina on sodium sulphate. GERMAINE MARCHAL. *Compt. rend.*, **188,** 258–60 (1929).—In order to determine the effect of the presence of silica or alumina on the temperature of dissociation of Na_2SO_4 these oxides were mixed with Na_2SO_4 and heated in an electric furnace. The weight losses at 1300°C for 3 hours for different mixtures were as follows: (1) $Na_2SO_4 + SiO_2$, 16.94%; (2) $2Na_2SO_4 + Al_2O_3$, 22.34%; (3) $Na_2SO_4 + Al_2O_3$, 18.21%; (4) Na_2SO_4 alone, 4.23%. H.I.

Action of silica, alumina, and kaolin on barium sulphate. GERMAINE MARCHAL. *Compt. rend.*, **188,** 399–41 (1929).—Mixtures of barium sulphate with SiO_2, Al_2O_3, or kaolin were heated at 1200 and 1300°C in a rapid current of nitrogen, in order to entrain the acid gases evolved. Although $BaSO_4$ is not decomposed at 1300°C the SiO_2, Al_2O_3, and kaolin have an important activating action on the decomposition at this temperature and at 1200 in the case of SiO_2. All these reactions are rapid at the beginning but become finally very slow. These reactions may have practical importance in that $BaSO_4$ may be used instead of $BaCO_3$ in the glass and sugar industries. H.I.

Reactions between colloidal silica and lime. PIERRE JOLIBOIS AND LOUIS CHASSEVENT. *Compt. rend.*, **188,** 452–54 (1929).—Solutions of CaO and colloidal solutions of SiO_2 of known concentrations were mixed and stored. After definite intervals of time the solutions were analyzed for SiO_2 and CaO and the precipitates were weighed. From the experiments it is concluded that (1) SiO_2 is coagulated by the CaO, (2) CaO is fixed by the SiO_2 giving a hydrated calcium silicate (probably a monocalcium silicate), (3) CaO is adsorbed by the precipitate, this adsorption continuing for several months in solutions rich in CaO. H.I.

Solubility of $Mg(OH)_2$ at high temperatures. A. TRAVERS AND NOUVEL. *Compt. rend.*, **188,** 499–501 (1929).—The solubility of $Mg(OH)_2$ at high temperatures is important because of its presence in boiler feed waters, especially when waters are purified with Na_2CO_3 bearing in solution $MgCO_3$ which hydrolyzes at 180 to 200°C giving $Mg(OH)_2$ and H_2CO_3. Because of the vigorous attack of magnesia on glass, experiments were carried out in copper flasks at high temperatures and in paraffined glass flasks at ordinary temperatures (18°C). Titrations were made (1) by the electrometric method (hydrogen electrode) and (2) by direct titration with phenol red, the atmosphere being carefully freed of CO_2. At 18° the solubilities of $Mg(OH)_2$ were 2.45, 1.72, 1.85, 1.75 $\times$ 10^{-4} mols/liter. At higher temperatures the solubilities ($\times$ 10^{-4} mols/liter) were at 35°, 1.69; at 45°, 1.5; at 70–75°, 1.18; at 100°, 0.72; at 110°, 0.74; at 142°, 0.44; at 150°, 0.37; at 158°, 0.31; at 178°, 0; at 200°, 0. The presence of Na_2SO_4 increases the solubility considerably. H.I.

Colloidal solutions of alumina and chromic oxide and their desiccation. PAUL BARY AND JOSÉ V. RUBIO. *Compt rend.*, **188,** 625–26 (1929).—The solution of Al_2O_3 used was prepared by dialysis of an aqueous solution of aluminum acetate. The solution was dried in a porcelain container in an oven at 60°C. Microscopic observations were made of the resulting product and it is concluded that the deposited oxide is not composed of a homogeneous mass but of two different substances, the one solid, more or less opaque, with a tendency to be arranged in lines parallel to the level of the liquid and the other composed of a homogeneous gel. H.I.

Reduction of fused silicates by oxides of carbon. B. BOGITCH. *Compt. rend.*, **188,** 633–35 (1929).—The oxide of Cu is fused with the silicate by mixing the oxide with sodium silicate, the fusion being carried out in the presence of compressed air. The glass thus obtained is fused in silica tubes and a gas, CO_2 or mixtures of CO_2 with CO, is bubbled through the fused material. In an oxidizing atmosphere and in the presence of CO_2 alone, the blue silicate of Cu is stable but 2.5% of CO with the CO_2 causes the blue silicate to become green, with 9% CO it becomes white, with 11.5% an opaque brick red, and with 21.5% a transparent blood red. Above 26% CO no silicate is stable and there is a nearly complete reduction of the Cu. B. explains these phenomena by assuming the existence of a certain number of sub-oxides of Cu, with degrees of oxidation below that of Cu_2O which are unknown in the free state. H.I.

Conditions of formation and the constitution of clay-humus complex in soils. A. DEMOLON AND G. BARBIER. *Compt rend.*, **188,** 654–56 (1929).—The authors conclude from experiments which are described that colloidal clay is a factor in the fixation of

humic colloids in soils. The cations absorbed by the clay, particularly Ca, affect the formation of the clay-humus complex, since humus material precipitates in much lower concentrations of Ca in the presence of clay than in its absence. H.I.

Resistance to fracture (breaking strength) of unfired ceramic bodies. OTTO BARTSCH. *Keram. Rund.*, **35**, 121–24 (1927).—Bodies of different types show the following average breaking strengths (in kg./cm.^{2}); stoneware bodies, 7 to 8; porcelain bodies, 4 to 5; saggers, 5 to 7. Cast bodies generally show somewhat higher values. Hand-made glass pot bodies average from 10 to 19 kg./cm.^{2} while cast bodies average about 40% higher. The breaking strength is of theoretical importance because it is one of the few constants measurable in the unfired state which are suitable as a basis of classification of clays. The method of drying has a great effect on the strength. The method giving the highest values is (1) drying for 7 days in air, (2) drying to constant weight at 70°C, and finally (3) drying at 110°. Heating above 110 gives low values. Since individual values generally show considerable deviation from the mean only an average of a large number of determinations can be used with safety. The usual stationary lever apparatus for measuring cross-breaking strengths is described. Aging of the clay has considerable effect, the cross-breaking strength generally reaching a maximum value after 10 to 30 days' aging. The breaking strengths of clays appear to show some parallelism with their plasticities but there appears to be no close relation between breaking strengths and (1) content of fine clay as measured by elutriation, (2) ignition loss, (3) porosity, (4) drying shrinkage, (5) water content at normal consistency. There appears to be some relation between breaking strengths and water vapor adsorption. Addition of nonplastic material generally causes a decrease in breaking strength although the curve of content of nonplastics vs. breaking strength is very irregular, often showing in the cases of certain clays, maxima and minima. H.I.

Chemical analysis of silicates. JOSEF ROBITSCHEK. *Sprechsaal*, **61** [13], 233–35; [14], 257–60 (1928); for abstract see *Ceram. Abs.* **7**, [8], 576 (1928). R.A.H.

Protective effect and ultra-filtration of silicic acid hydrosol. WALTER KRONSBEIN. *Sprechsaal*, **61** [15], 279–81; [16], 296–99 (1928).—The results obtained in an investigation determining the protective effect of three different hydrosols of silicic acid and the use of a colorimetric method confirmed the results obtained by ultrafiltration. R.A.H.

Iron oxide in the firing losses of ceramic bodies. FRIEDRICK DETTMER. *Sprechsaal*, **61** [17], 318–19 (1928).—Iron oxide is not stable above 1300°C, it converts to ferrosoferric oxide with separation of oxygen. Since most ceramic bodies contain iron oxide and are sintered at this temperature a swelling will result (air pockets). Oxygen compounds of iron are reducible to the lower (ous) form by means of excess gases, making it possible through reduction at the proper time to avoid gas pockets in the pottery. Carbon does not color ceramic bodies yellow, but will sometimes lead to small blisters. Sulphur has an active coloring power especially for glasses and glazes; bisque ware, on the contrary, is only slightly affected, with the exception of certain susceptible porcelain bodies. R.A.H.

Determining MgO quickly. S. G. LASKY. *Eng. Min. Jour.*, **124** [21], 814 (1927).—Dissolve 1 g. of sample in dilute HCl. Without filtering off any insoluble material, make strongly ammoniacal and add two or three drops of $(NH_4)_2S$ or its equivalent to precipitate any metallic sulphides. Heat to boiling and add enough $(NH_4)_2C_2O_4$ to bring down all calcium. Filter, evaporate the filtrate to dryness and ignite in a muffle for about 15 min. Weigh the residue as MgO. This method is especially applicable to dolomitic limestones. A.J.M.

Anorthoclase in caucasites. D. S. BELYANKIN. *Bull. acad. sci. Russ.*, pp. 1115–23 (1927).—B. classifies the anorthoclases with orthoclases and distinguishes the 4 series:

K and Na anorthoclases, either with low or medium values of $2V$ or with high values of $2V$. It is suggested also that the anorthoclases with low or medium $2V$ be termed K sanidine (or simply sanidine) and Na sanidine, respectively. K sanidine occurs widely in igneous rocks, principally in intruded materials and mostly in those of recent age. (*C.A.*)

Decomposition of silicates by strontium salts in metals. J. KAVINA. *Chem. Listy*, **22**, 267–70 (1928).—$SrCl_2$ or a mixture with NH_4Cl is used for fusion with silicates in the determination of alkali metals in the latter. This fusion mixture corrodes Pt vessels; Ni crucibles cannot be used. Precipitation of Sr as carbonate from aqueous extracts of the fused mass is not as complete in the presence of alkali chlorides as in their absence, 0.1 mg. of Sr being, however, readily precipitable from 3 cc. of a solution containing 0.2 g. of alkali chlorides, $SrCl_2$ used alone does not yield satisfactory results. (*C.A.*)

Fine structure of the feldspars. E. SCHIEBOLD. *Fortschr. Mineral. Kryst. Petrog.*, **12**, 78–82 (1927).—The monoclinic feldspars are basal-face-centered, the edges of the unit cell being parallel with the crystallographic axes *a*, *b*, and *c*. Values of a_0, b_0, and c_0, respectively, are as follows: adularia, 8.61, 13.07, 7.26; sanidine, 8.42, 12.92, 7.14; microcline, 8.44, 13.00, 7.21; hyalophane, 8.50, 12.92, 7.12; albite, 8.23, 13.00, 7.25; oligoclase, 8.16, 12.90, 7.13; labradorite, 8.23, 12.91, 7.16; anorthite, 8.185, 12.895, 7.09 A. U. The space-group for the monoclinic feldspars is C^3_{2h}, and for the triclinic, C_i^1. The effect of changes of composition on the dimensions of the unit cell is considered. (*C.A.*)

A graphic method for solving simple stoichiometric problems. CHARLES H. STONE. *Jour. Chem. Education*, **5**, 1444 (1928).—On a sheet of cross-section paper, ruled in tenths, choose a point in the lower left-hand corner as origin and through it draw two lines at right angles as axes. Find next the values concerned in the problem, *e.g.*, 87 g. of MnO_2 will liberate 71 g. of Cl_2 from HCl. Locate the point 87–71 and from it draw a line to the origin. Any point on this line will mark the intersection of two perpendiculars, one drawn from a position on the ordinate representing a given value, and the other to a point on the abscissa representing the corresponding value of the answer. (*C.A.*)

Influence of p_H and electrolytes on the turbidity, sensitivity, and settling rates of certain Pleistocene clays. H. C. GRAHAM AND J. N. PEARCE. *Proc. Iowa Acad. Sci.*, **34**, 217–18 (1927).—The amount of clay which can be held in aqueous suspension depends on the stratum from which the clay was obtained, on the p_H, and on the concentration of the electrolyte present in the suspension. Generally the turbidity is maximal at p_H 10.5. (*B.C.A.*)

Waterproofing clays. B. S. SHVETZOV AND K. G. ELSHANKIN. *Trans. State Expt. Inst. Silicates* (Moscow), No. 21, 73–89 (1927).—Different clays when made up to a dough, or air dried, differ in their rate of disintegration when immersed in H_2O. The problem was to increase the time interval necessary for the H_2O to penetrate the clay, thus giving it greater stability. Additions of Na_2SO_4, $CuSO_4$, or $CaCl_2$ showed no effect. H_2SO_4 and Na_2SiO_3 alone and mixtures of these in different proportions increased the time from 7 or 9 min. to 2 hrs. and 45 min. for the 5 cc. addition of a 10% H_2SO_4 solution to 18 g. of clay. Several other trials with different per cents of H_2SO_4 showed that 2 to 3% is the best amount. The possible reactions which might cause these clays to resist the entrance of H_2O upon treating with H_2SO_4 are not explained. S. and E. suggest the possible formation of compound of the oxides of Al and Fe with SO_4. When fibrous material, such as asbestos or peat, was added in conjunction with H_2SO_4 the clay did not form any cracks, but the time interval was not increased. The H_2SO_4 has no effect on shrinkage. (*C.A.*)

The action of sulphuric acid on clay at ordinary temperatures. P. N. GRIGORJEW AND P. I. GALKIN. *Trans. State Expt. Inst. Silicates* (Moscow), No. 21, 91–95 (1927).—The authors conducted a series of experiments to determine the chemistry of the phenomenon reported in preceding abstract and formation of "keramolit" or "waterproof" clay. The postulate was that gypsum is formed in the reaction between the Ca of the clay and the H_2SO_4 and this binds the clay. Eleven different kinds of clays and kaolins were treated with H_2SO_4, kneaded into pyramids and immersed in H_2O. The time period the pyramids kept their shape under water served as an index for the effect of the H_2SO_4 on the waterproofing of the clays. The results of the experiments are summarized: (1) "keramolit" cannot be prepared from any clay; (2) there can be no set rule as to which of the clays is capable of forming it; (3) there is no proof that the formation of gypsum is responsible for imparting the "keramolit" property to clays: clays with a high Ca content gave no "keramolit" while other clays with a low Ca content did give "keramolit;" (4) the explanation offered is the dehydration of the clays by the H_2SO_4; the presence of impurities in clays, especially Fe, seems effective in the formation of the "keramolit." (*C.A.*)

The problem of active silica. Soluble silica in clays. A. FIOLETOVA. *Trans. State Expt. Inst. Silicates* (Moscow), No. 21, 111–13 (1927).—Clay samples were dried at 100 to 110°, ground in an agate mortar, treated for 1 hr. with constant stirring with *N* HCl following the method of Dementev (V. G. Dementev, Scientific Principles of the Technic of Cement, 1905). The 2 clays treated gave up 0.05 and 0.09% SiO_2. The clays were then heated to 530°, the sample being allowed to cool 2.5 hrs. between the 2 heatings. After each heating the clays were treated again as above with HCl. After 2.5 hrs. cooling the amounts of SiO_2 extracted from the 2 clays were 0.25 and 0.17%. When extracted immediately after heating, the SiO_2 content was 0.29 and 0.17%. The clays were also heated to 1300° and in this case the HCl extract gave 0.21% SiO_2 for the first sample and none for the other. (*C.A.*)

Experiments on the purification of clay by electrophoresis. A. S. TAL. *Trans. State Expt. Inst. Silicates* (Moscow), No. 21, 115–31 (1927).—The electrophoresis of clay was resorted to in an attempt to purify it for various purposes. At first the ordinary laboratory outfit was used, but later a bath of a semifactory style was introduced. The anode used after a series of trials was hard lead (an alloy of Pb and 14% Sb). Various electrolytes were tested: soluble glass, soda, and ammonia. The latter gave the least difficulties and was used throughout the 250 experiments. With a current of 80 v. the gas accumulations at the anode were a hindrance and a depolarizer was introduced. Peat extract was found to serve the purpose. The final outlay of the experiment was as follows: the clay was ground in a ball mill, sieved through a 900-mesh sieve, mixed with H_2O (2 kg. of clay per l. of H_2O), ammonia added in excess, the current (0.008 to 0.012 amp. per sq. cm.) varied between 75 and 120 v. The clay thus obtained upon heating gave a lighter product and its contracting upon heating to high temperatures was greater than that of contracting when heated up to 100°. Tests were also made on methods of removing the Fe present in forms other than silicates. The magnet was resorted to but without success which was attributed to the weak magnet used. A powerful magnet is contemplated. (*C.A.*)

The determination of the reaction of clay and kaolin. P. N. GRIGORJEW. *Trans. State Expt. Inst. Silicates* (Moscow), No. 21, 133–36 (1927).—G. describes a method of titrating clay extracts (200 g. in 1000 cc. H_2O), using phenolphthalein and methyl orange as indicators. (*C.A.*)

System: beryllium oxide–silicon dioxide. F. MACHATSCHKI. *Z. physik. Chem.*, **133,** 253–62 (1928).—Comparison of the Debye-Scherrer diagrams given by mixtures of BeO and SiO_2 in proportions corresponding with the ortho- and meta-silicates indicates

the existence, at temperatures between 1000° and the melting point, of the orthosilicate phenacite. Both molten phenacite and molten mixtures of the 2 oxides yield (when cooled rapidly) crystalline BeO and a glass containing BeO; Be metasilicate cannot be obtained by this method and is probably not stable in the crystalline condition.

(*C.A.*)

BOOKS

Annual Tables of Constants and Numerical Data of Chemistry, Physics, Biology, and Technology. Published by the International Research Council and the International Union of Pure and Applied Chemistry.—Two sets of tables are announced, one dealing with the engineering and metallurgical constants and the other dealing with electricity, magnetism, and electrochemistry. The first contains 169 pp., price 100 fr. The second contains 174 pp., price 90 fr. These are both reprinted chapters of Volume VI, (1923–24) of the tables published by these organizations. The charges made for works of this kind bear no relation whatsoever to their value as they represent the time of leading scientists given freely in their compilation. Orders should be sent to Gauthier-Villars & Cie., 55 Quai des Grands Augustins, Paris, VI. Reviewed in *Can. Chem. Met.*, **13** [3], 48 (1929). E.J.V.

Catalytic Processes in Applied Chemistry. T. P. HILDITCH. Chapman and Hall, Covent Garden, W. C. 2, England. 347 pp., price 16/ net.—The principles of catalytic action as applied in practice are discussed. These are classified as (1) catalysis at surfaces of solid inorganic materials, (2) catalysis at surfaces of colloidal organic compounds (fermentation processes), (3) homogeneous catalysis in liquid systems. The first chapter is an essay on the development of our knowledge of catalysis. 80% of the text relates to specific industrial applications. The catalytic production of some 48 individual or group products is described from an industrial chemical point of view. It is no easy task to secure data on commercial catalytic methods with all due respect to the patent or other literature, but this book does present in concise form probably more information of this kind than has been available to the general reader. Reviewed in *Can. Chem. Met.*, **13** [3], 48 (1929). E.J.V.

Fundamentals of Quantitative Analysis. W. C. BLASDALE. 3rd ed. D. Van Nostrand Co., New York. 400 pp., price $3.75. Reviewed in *Can. Chem. Met.*, **13** [3], 48 (1929). E.J.V.

Chemical Dictionary: German, English, French. Vol. I. A. W. MAYER. Pp. xii + 826. Otto Spamer, Leipzig, 1929. Price 75 R.M.—The names of chemical substances and apparatus in each language are given their equivalents in the other two languages. In order to dispel any doubt, the chemical formula of the substance and an explanation of the apparatus are also given. Reviewed in *Chem. News*, **138**, 157–58 (1929). H.H.S.

PATENTS

Process for the manufacture of titanium oxide. JOSEPH BLUMENFELD. U. S. 1,707,248, April 2, 1929. A process for the removal of ferrous sulphate from a solution containing titanium, ferrous iron, and sulphuric acid, which comprises cooling the solution to about +5°C or less, and separating out the ferrous sulphate crystals formed at low temperature.

Production of titanium tetrachloride. CHARLES DE ROHDEN. U. S. 1,707,257, April 2, 1929. A process for the production of titanium tetrachloride which comprises mixing carbon, a titaniferous substance, and a colloidal suspension of titanium dioxide, drying the mixture to produce a tough mass, and subjecting fragments of the mass to the action of chlorine.

Chromium oxide. J. Y. JOHNSON. Brit. 304,809, March 20, 1929. Green hydrated chromium oxides for use as pigments, etc., are obtained by heating chromic acid or its

salts and water with reducing agents (other than sulphurous acid) under a pressure not exceeding 150 atmospheres. The process for the production of such oxides is excluded from the scope of the invention. Organic or inorganic reducing agents may be used, for instance hydrogen, hydrocarbons, carbon monoxide, formates, glycerine, or sodium thiosulphate. *E.g.*, a solution of sodium chromate is reduced with carbon monoxide at 270 to 280 °C or at 200 to 210 °C in an autoclave, a darker oxide being obtained at the lower temperature; sodium formate or glycerine may be used as reducing agent; a solution of sodium chromate is reduced with flowers of sulphur, lampblack, or powdered wood charcoal under a pressure of 40 atmospheres; a solution of sodium bichromate is reduced with hydrogen or a mixture of carbon monoxide and hydrogen at 250 to 260 °C and a solution of potassium chromate is reduced with hydrogen or a mixture of carbon monoxide and hydrogen at 270 °C under a pressure of 110 atmospheres.

White titanic acid. I. G. FARBENIND. A.-G. French 641,712, Oct. 1, 1927. Reducing agents such as SO_2 or its salts which cannot transform quadrivalent Ti into tervalent Ti are used for the production of white titanic acid, and in such a concentration as to correspond not only with all the tervalent Fe present but with all the other oxidants present. During the subsequent washing, reoxidation of the Fe is prevented. (*C.A.*)

General

Ceramic expositions. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **8** [4], 65–67(1929).—Purposes, results, and values of expositions are discussed. The features and values of ceramic expositions of different types are pointed out. Particular reference is made to the national ceramic exposition during Ceramic Week, the New Jersey Ceramic Exposition, the building material show in Canton, and the clay product shows held in Chicago in 1912 and 1913. E.J.V.

Ceramic exposition in New Jersey. ANON. *Bull. Amer. Ceram. Soc.*, **8** [4], 85–89 (1929); *Clay-Worker*, **91** [3], 357 (1929); *Glass Ind.*, **10** [4], 96 (1929).—An exposition of ceramic products produced in the state, and embracing a wide range of accomplishment, including brick, hollow tile, terra cotta, floor and wall tile, chinaware, sanitary ware, porcelain specialties, refractories, glassware, etc., was held under the auspices of the Ceramic Club of the Department of Ceramics, Rutgers University, New Brunswick, N. J., March 8 to 16, 1929. E.J.V.

British ceramists our guests. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **8** [4], 67 (1929).—A brief note regarding the three weeks tour of the U.S. and part of Canada made by members of the Ceramic Society and the Refractories Assn. of Great Britain. E.J.V.

Refractories advisory board for Penn State. ANON. *Bull. Amer. Ceram. Soc.*, **8** [4], 80–81 (1929); *Cement, Mill, and Quarry*, **34** [4], 27 (1929); *Clay-Worker*, **91** [4], 325 (1929).—Ten prominent men in the refractories industry from Pa. have been appointed to form an advisory board for the School of Mines and Metallurgy of the Pennsylvania State College. The function of the board is explained and the members named. E.J.V.

Federal Trade Practice Conference. I. WILLIAM C. KOCH. *Brick Clay Rec.*, **74** [8], 524–27 (1929).—The subject of the Trade Practice Conference is of importance and interest not exceeded by any matter now confronting the clay products industry. This is the first of a series of articles explaining its significance to the industry. In this article an attempt is made to picture the basis upon which a Trade Practice Conference rests. E.J.V.

American Industrial Exposition. ANON. *Ceram. Ind.*, **12** [4], 440–41 (1929).—The American Industrial Exposition opened at the Metropolitan Museum of Art, New York City, Feb. 12, and continues to Sept. 2. Nine of the most prominent architects

and designers in the city collaborated with the Museum in this exhibition and a number of months' hard work has been spent on the many exhibits and the 12 group rooms and entrance and central garden feature. Manufacturers numbering 150 different companies were represented in the work of exhibits and rooms. The dominant note of the exhibit was utility combined with beauty of design and simplicity. Pyrex power line insulators, made by Corning Glass Works, used on big voltage transmission lines were shown. They are positive of unusually high permanent dielectric strength and electrical resistance. They are transparent to solar heat, resist power arcs, and have an extremely low linear coefficient of expansion namely 0.0000032°C and are chemically stable. Due to their transparency they may be easily inspected for internal defects. F.P.H.

Canton builders' show. ANON. *Clay-Worker*, **91** [3], 215–16 (1929).—The annual Canton builders' show and the part taken by clay product manufacturers in boosting their materials are described. Clay products manufacturers participating included Belden Brick Co., Metropolitan Paving Brick Co., Canton Brick and Fireproofing Co., Stark Brick Co., and the Whittacre-Greer Fireproofing Co. E.J.V.

Sand Lime Brick Association. ANON. *Clay-Worker*, **91** [3], 269 (1929).—A report of the 25th anniversary held in Washington Feb. 5 to 7. E.J.V.

Structural Tile Association committees. S. F. HECKERT. *Clay-Worker*, **91** [4], 322–23 (1929).—The personnel of twelve committees is announced, with one committee to be announced later. E.J.V.

Cement Association holds annual meeting at Chicago. ANON. *Cement, Mill, and Quarry*, **33** [4], 44–46 (1928).—Annual meeting of the Portland Cement Assn., was held at the Blackstone Hotel, Chicago, Nov. 19 to 21. E.P.R.

Pottery and glassware at the British Industries Fair. ANON. *Pottery Gaz.*, **54** [622], 596–620 (1929); see *Ceram. Abs.*, **8** [5], 377 (1929). E.J.V.

British pottery and glass exhibits at Leipzig Fair. ANON. *Pottery Gaz.*, **54** [622], 630–31 (1929).—There were stalls at the Leipzig Spring Fair at which the German representatives of several British firms exhibited British pottery. These exhibits are described. Among foreign exhibitors at Leipzig were Danish, Dutch, Swedish, Czech, Austrian, Italian, and even a Japanese firm. E.J.V.

Industrial arts show. ANON. *Cement, Mill, and Quarry*, **34** [4], 22 (1929).—Approximately 1700 lines of manufactured products will be featured in the Industrial Arts Show, Eastern States Exposition, Springfield, Mass., Sept. 15 to 21. E.P.R.

Barcelona International Exhibition. ANON. *Chem. News*, **138**, 167 (1929).—To be held at Barcelona, Spain, from May to Dec. this year. This exhibition is the most important international one held since the war. All the leading nations are represented by exhibits. H.H.S.

Swiss Industries Fair. ANON. *Chem. News*, **138**, 191 (1929).—The thirteenth annual fair of the industries of Switzerland was held at Bâle (Basle), April 13 to 23. There was a notable increase on previous years both in the number of exhibitors and in the range of subjects. Ceramics and applied arts were grouped in one section. There were 21 sections. H.H.S.

Nonmetallic raw materials in Pacific Northwest. ANON. *Brick Clay Rec.*, **74** [8], 533 (1929).—The value of clay products manufactured annually in the three states of Wash., Ore., and Idaho is now passing the million dollar mark. These products are practically all structural wares such as brick, tile, sewer pipe, and architectural terra cotta. The only potteryware made are red flower pots from several small plants, some stoneware from Portland, and some faience tile. In contrast to conditions in other sections, where the various raw materials required for the manufacture of pottery must be collected from widely scattered places, it is possible for a pottery in the north Pacific

area to acquire its own deposits of these essential raw materials and do its own mining and preparation. Plastic kaolins are found in large quantities in Wash., near Spokane, and in Idaho near Troy and Moscow. Feldspar is found near Troy, Idaho, and at Deer Harbor, Wash. E.J.V.

Canadian clay industry. ANON. *Brick Clay Rec.*, **74** [8], 540 (1929).—At the meeting of the Canadian Mining and Metallurgical Institute, W. G. Worcester gave a paper on "Saskatchewan Clays of Dominion Importance," and J. G. Phillips one on "Treatment of Tender Clays to Overcome Drying Defects." S. J. Cook of the Department of Statistics, Ottawa, gave a report of clay products production in Canada in 1928, which showed a total production of $12,682,780 worth in 1928 as compared with $11,173,189 in 1927. E.J.V.

Special clay products manufactured in Ontario. ANON. *Can. Chem. Met.*, **13** [3], 36 (1929).—Nearly all the special claywares manufactured in the Province are made from imported clays, china clay from England, and fire clays, ball clays, etc., from the U.S. The principal product of the industry is electrical porcelain insulators, the output of which amounted in value to $1,025,224 in 1927. In the same year, floor and wall tile valued at $169,978 were manufactured in Ontario. Fire brick, fireclay blocks and shapes, and pottery work worth $161,485 were produced. Manufacturers of special clay products in Ontario are listed. E.J.V.

Obsolescence. ANON. *Brick Clay Rec.*, **74** [7], 466–70 (1929).—In this day of rapid mechanical development, manufacturers must realize that machinery is obsolete, regardless of its age, immediately when new machines have been perfected which will produce cheaper and better ware. Machines and equipment become obsolete for several reasons: (1) a change in processing may require a new machine; (2) because of danger attendant in operating a machine junked; and (3) new refinements in existing machines may make present installed machines obsolete. It is in the latter cause we are interested, and it is a problem to determine when it is profitable to replace equipment with improved machines. Due to continual changes and improvements in manufacturing processes it is often essential to rip out a machine which has been giving apparent satisfactory service and which is not actually worn out, to be replaced by the newly developed machine which will make a better product at lower cost. The clay industry is one which is undergoing a rapid change toward maximum mechanical efficiency. New clay machinery is being developed rapidly which will make a better product quicker with fewer power and labor. Several of the improvements made in clay machinery are: (1) pug mill of radically different design which insures quicker operation, a better product, fewer repairs, and lower power costs; (2) a granulator and grinder which make a better product and have greater capacity; (3) a combination machine which has greater capacity at lower cost; (4) a brick machine of smoother operation and less labor; (5) a cutter of sturdier construction and speedier operation, etc. It is in keeping with these refinements in machinery that clay products manufacturers must consider seriously the problem of obsolescence. Discussions of the general subject by several authorities are also given, as are examples of what is being done by the ceramic industry. E.J.V.

Team work in the clay products industry. SEWARD C. SIMONS. *Clay-Worker*, **91** [3], 230–31 (1929).—An address by the Secretary Manager of the Clay Products Inst. of Calif. read before the 11th Annual Convention of the Common Brick Mfrs. Assn. E.J.V.

Clay testing laboratory. ANON. *Clay-Worker*, **91** [3], 269 (1929).—In order to determine whether or not fine clays exist in the San Antonio (Tex.) district, the industrial department of the Chamber of Commerce is asking for samples of 20 to 50 lbs. of clay to be found anywhere in the trade territory. These samples will be tested and fired to

see whether the clay can be used for the manufacture of fine chinaware, tableware, floor tile, wall and roofing tile, sanitary ware, etc. The equipment installed includes two kilns, several pebble mills, and some scientific apparatus. E.J.V.

Unique common brick display. ANON. *Clay-Worker*, **91** [4], 303–304 (1929).—The Chicago Brick Exchange has an unusual exhibit of common brick in its headquarters room in the Builders' Building, which attracts hundreds of prospective buyers. Photographs of some of the exhibits are included. E.J.V.

Clay in 1927. JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources of the U.S.*, Part II, pp. 257–68 (1928).—The tables of production given in this article represent chiefly the clay that was mined and sold. The domestic clay-mining industry in 1927 was fairly active. While both the total quantity and the total value of clay sold by producers decreased slightly, 3%, compared with 1926, the sales of kaolin, ball clay, and stoneware clay increased in both quantity and value. The total sales of clay in 1927 were exceeded in quantity by 2 yrs. (1925 and 1926) only, and were 24% greater than those of 1917. In 1927, for 2 of the higher-grade clays, kaolin and ball clay, sales reached their maximum quantity and value. Fire clay was the only important kind to show a decrease. Sales of domestic kaolin, the chief clay used in the manufacture of high-grade ceramic ware, paper, etc., increased 5% in quantity over 1926, whereas the imports of kaolin or china clay decreased 14%. The southern states are the chief source of supply of kaolin, producing 81% of the total in 1927. Ga. the largest producer, reported 43% of the total. Ball clay, increased 7% in quantity and 5% in value compared with 1926. Slip clay, a low temperature fusing material that formerly was used chiefly as a glaze on stoneware, now finds its main use as a binder in the manufacture of artificial abrasives. In 1927 sales of slip clay decreased about 29% in quantity and value compared with 1926. Stoneware clay increased 17% in quantity and 10% in value as compared with 1926. Fire clay which constituted 70% of the total quantity of clay sold by producers in 1927, decreased 4% in quantity and 5% in value compared with 1926. The sales of fire clay in 1927 were the second largest recorded being exceeded by those of 1926. Detailed data on the production and sales of various clays together with production by uses are given. The English china-clay industry is discussed as also are the exports and imports. R.A.H.

Study of quarry costs. J. R. THOENEN. Bur. Mines, *Rept. of Invest.*, Serial No. 2911, 12 pp. (Feb., 1929).—During the year 1927, the Bureau of Mines, at the request of a number of quarry operators, undertook to make a study of quarry operating costs in order to determine average costs for certain operating conditions and to suggest a model cost accounting system for quarry operations. The present report covers a series of tabulations on the quarrying and preparation of limestone. The tables refer to the following subjects: quarry and overhead costs per short ton, removing loam and clay overburden, drilling, blasting, loading, power shovel duty, transportation, crushing, storage, drying, screening, elevating, and conveying. Final tabulations will cover trap, granite, and sandstone in a similar manner. R.A.H.

Quarry practices. S. R. RUSSELL. *Cement, Mill, and Quarry*, **33** [4], 18–24 (1928).—The development of shovels, drills, and the snakehole and coyote tunnel methods of blasting are described in detail. E.P.R.

Methods of drilling and blasting trap rock. F. H. EDWARDS. *Cement, Mill, and Quarry*, **34** [3], 22–23(1929); *Pit and Quarry*, **17** [11], 36 (1929).—Because the ledge formations of the trap rock are different as to structure and seams in their different quarries, the Conn. Quarries Co. resorts to three different drilling and blasting methods. Well drilling, snakehole drilling, and tunnel shooting are the three methods used. No one type of blasting was found to be most effective for the eight quarries operated by the company. R.G.E.

Inspection and insurance of quarry machinery. A. C. WILSON. *Pit and Quarry*, **17** [11], 57–60 (1929).—The inspection and care of quarry machinery is discussed. Causes of accidents and the human element involved are considered. Crane and stone crusher breakdowns and air compressor explosions are especially dealt with. R.G.E.

Electrical accident prevention. L. C. ILSLEY. Bur. Mines, *Information Circ.*, No. 6100, 8 pp. (Feb., 1929).—This circular was written from the viewpoint of safeguarding life, machinery and apparatus with reference to electrical equipment as used in the mining industry. Hazards from various sources are discussed and means for minimizing them are outlined. R.A.H.

Cost of carelessness. F. V. LARKIN. *Abrasive Ind.*, **10** [4], 31 (1929).—Eighteen million working days or the time of 60,000 persons, are lost yearly in this country as a result of accidents, most of which are avoidable. The loss is $100,000,000 annually. Primary blame for these is laid upon management; hence the importance of training engineering students in safety devices and measures. E.P.R.

Safety in welding. ANON. *Amer. Glass Rev.*, **48** [23], 25 (1929).—Welding practices are discussed with the outstanding health and accident hazards involved and suggestions for overcoming them. The effects that various light rays exercise upon the body and the methods utilized for protection against such rays are discussed in detail in this publication. This study has been made and published for officials of organizations in which welding has become an important operating process or where it is used as a medium of maintenance and repair. E.P.R.

Industrial accident prevention. G. H. W. CAM. *Can. Congress Jour.*, **8** [2], 25–28 (1929).—C. describes the trophy competitions, weekly papers, departmental dials, and other devices which act as propaganda for the elimination of accidents. H.H.S.

Effect of accident prevention program on production. P. H. JACOBY. *Pit and Quarry*, **17** [11], 52 (1929).—Production suffers in every way from accidents. Accidents cannot occur without destroying the morale of the entire plant. An effective accident prevention program increases plant efficiency by creating among the workmen a feeling of confidence in their safety. R.G.E.

Modernizing pays. ANON. *Abrasive Ind.*, **10** [4], 23 (1929).—In 1928, 87 railroads bought 2377 tool units, compared with 2172 units bought in 1927 by 99 railroads. Generous purchases of grinding equipment and increasing use of material handling equipment show the trend to modernization. E.P.R.

Open feldspar grinding plant at Burnsville, North Carolina. ANON. *Cement, Mill, and Quarry*, **33** [4], 34 (1928).—The new 75-T. feldspar grinding plant is located at Burnsville, N. C. E.P.R.

New feldspar mill. ANON. *Cement, Mill, and Quarry*, **34** [4], 17 (1929).—U. S. Feldspar Corp. has completed a new mill on a 3500 acre tract near Cranberry Creek, N. Y. An aerial tramway connects the main quarry operations located 2 miles from the mill site. The new mill has a capacity of 5 T. an hour. A similar unit will be installed in the near future. E.P.R.

Research on wire rope. ANON. *Cement, Mill, and Quarry*, **33** [4], 48 (1928).—Research into the causes of breakdown in wire rope is being organized by a committee of the A.S.M.E., jointly with Engineering Foundation. It is planned to construct a testing machine which can reproduce all the varied service conditions to which such rope is subjected. The society would be glad to hear from technical men particularly interested in any phase of the manufacture or use of wire rope. E.P.R.

Effectiveness of expert explosives service. ANON. *Cement, Mill, and Quarry*, **33** [4], 68–70 (1928).—Consultation with explosives experts proves helpful in many cases. Service has been utilized satisfactorily for over ten years. E.P.R.

Improved bucket for cableway excavators. ANON. *Cement, Mill, and Quarry,* **33** [4], 78 (1928).—An improved type of excavating bucket for slackline cable-way excavators was recently placed on the market by Sauerman Bros., Inc., Chicago, Ill. The Sauerman engineers who designed this bucket have named it the "Universal" because it is adaptable to so many different digging conditions. E.P.R.

Increasing production of belt driven machines. ANON. *Cement, Mill, and Quarry,* **33** [4], 80–81 (1928).—Pulleystone, applied to the surface of iron, steel, or wood pulleys, will give them an efficiency equal to or better than that of a new paper pulley. It is applied to the small pulley of producing machines and to motor pulleys. E.P.R.

Springing bore holes in rock that ravels. A. E. ANDERSON. *Cement, Mill, and Quarry,* **34** [2], 51 (1929).—When it is necessary to spring bore holes to load large charges of explosives inconvenience and danger often arise due to the explosion of the springing charges cracking and jarring the rock, leaving a ragged instead of a smooth hole. Trouble may be largely avoided by stemming on the springing charges. E.P.R.

Institute of Mining and Metallurgical Engineers. ANON. *Cement, Mill, and Quarry,* **34** [4], 28–29 (1929); see also *Ceram. Abs.,* **8** [5], 376 (1929). E.P.R.

Superiority of the Diesel engine. JULIUS KUTTNER. *Cement, Mill, and Quarry,* **34** [4], 47–48 (1929).—The Diesel engine offers a desirable improvement over both steam and gasoline power. A quantitative comparison of operating costs and performance efficiencies is given. E.P.R.

Developments in blasting with L.O.X. ANON. *Cement, Mill, and Quarry,* **34** [4], 51–53 (1929).—The first public demonstration in the U.S. of blasting with liquid oxygen explosive (L.O.X.) took place in 1923, at the quarry of the Kelly Island Lime and Transport Co., near Martinsburg, W. Va. Since then much experimental work has been done. Comparative costs and effectiveness are given with methods of using under different conditions. E.P.R.

Measurement of pipe flow by the coördinate method. F. W. GREVE. *Blast Fur. Steel Plant,* **17** [3], 446 (1929).—The investigation was conducted in the hydraulic laboratory of Purdue University to determine: (1) the empirical relation between the rate of discharge from a horizontal pipe and the coördinates of the upper surface of the issuing steam, or jet, measured from the top, inside of the pipe at the point of discharge; (2) the relation between the actual mean velocity within the pipe to that indicated by the law of a freely falling body *in vacuo* as applied to the upper surface of the jet; and (3) the possibilities and limitations of the method, especially as to the effect of the personal element in taking measurements. The coördinate method of determining pipe flow is simple, inexpensive, and practical for field tests where a maximum error of 10% is permissible. The discharge in cubic feet per second, q, from partially filled pipes with limiting nominal diameters of 2 and 6 in. and with a ratio of depth to diameter, k, at the outlet between 0.2 and 0.6, can be computed from the equation, $q = 9.43\ [d]^{2.56}[k]^{1.84}$ where d is the true diameter in ft., and $q = 0.018\ [d]^{2.51}[k]^{1.84}$ where d is the nominal diameter in inches. Tabulated values of the rate of discharge listed will be found more nearly correct and more convenient to handle than computations invoking the application of the law of a body falling freely *in vacuo* to the jet. F.P.H.

Simplified practice in industry. ANON. *Pit and Quarry,* **17** [13], 52 (1929).—The Commercial Standards Group announces 24 simplified practice recommendations for 1928 with an average support of 87.03% in conformity with the respective programs. The survey covered 12 recommendations in the building and construction materials field, with an average degree of support of 87.45%; 7 in the hardware and mill supply field, with an average adherence of 80.17%; two for plumbing supplies at 98.83%; and three in miscellaneous fields at 91.88%. R.G.E.

Advantages of reduced inventory. J. R. GAMBLE. *Pit and Quarry,* **17** [13], 75–76

(1929).—In former years the average executive of a manufacturing plant did not feel at ease unless the inventory was large enough to insure him against almost any unforseen contingency. Recently, the inventory has been given considerable more attention by a number of concerns, and they have found that there are genuine benefits to be derived by studying it. The excellent service being rendered by the manufacturers and transportation companies, together with the fact that the buyer and seller are assisting each other in every possible way, makes it unnecessary to load up the stock room with an excessive amount of supplies and hence tie up much money. To have the right goods on hand at the right price and in the proper quantity requires careful study and the purchasing agent, together with his staff, must be constantly on the job. A "hand to mouth" buying policy can be worked out satisfactorily if visible stock records and a perpetual inventory are kept. Recording purchases on cards and consulting them before buying precludes the possibility of purchasing material already on hand or on order, and prevents overstocking. R.G.E.

Development of V-belt drives. ANON. *Pit and Quarry*, **17** [13], 79 (1929).—In the last few years there has been considerable development in the use of elastic V-shaped belts in multiple instead of ordinary flat belt type of drive or in place of chain drives. Such drives are applicable to almost any type of service and their use has solved many baffling power transmission problems. A V-belt drive makes possible the use of short centers with higher speed motors; they require no lubrication and operate silently without vibration. Due to the wedging action of the belts in the grooves and to their inherent elastic qualities there is no sudden grabbing of the load and sudden shocks to the driving and driven machines are eliminated. R.G.E.

Marking porcelain and laboratory vessels. A. W. KNAPP. *Chem. and Ind.*, **48**, 290 (1929).—For identification marks on vessels that are required to stand heat and ordinary cleaning operations, the following formula is recommended: 3 g. Pb acetate, 3 g. Mn nitrate, 0.02 g. methyl green, 0.03 g. glacial acetic acid, 9 cc. water, and a little dextrin to improve it as a writing fluid. A solution of $PtCl_4$ makes a good mark, but is expensive. Cobalt nitrate is effective and cheaper than $PtCl_4$. H.H.S.

Merchandise marks. E. W. REARDON. *Chem. News*, **138**, 199 (1929).—The British Board of Trade has appointed a committee under the Merchandise Marks Act to inquire whether certain classes of imported goods should not bear an indication of their country of origin. Among these classes are glassware, brick and tile, Portland cement, and asbestos cement products. See also *Bull. Amer. Ceram. Soc.*, **7**, [9], 298 (1928). H.H.S.

Industrial research and the protection of scientific property. R. BRIGHTMAN. *Chem. Practitioner*, **2** [9], 3–8 (1929).—The draft Convention for the Protection of Scientific Property which was adopted by the International Committee on Intellectual Coöperation at its meeting last August has now been circulated to Governments for their approval. Its main principle is that authors of scientific discoveries should share in the material profits derived from the industrial exploitation of the discoveries, and that neither patent law nor the law of copyright at present help them to do this adequately. H.H.S.

Industry in the maritime provinces. A. E. FLYNN AND OTHERS. *Ind. Can.*, **29** [12], 41–57 (1929).—This is a special number featuring Nova Scotia and the other maritime provinces of Canada. Among the numerous photographs is one of the New Glasgow plant of Standard Clay Products, Ltd. H.H.S.

Power production in Europe. W. O. BLANCHARD. *Sci. Monthly*, **28**, 62–66 (1929).—Power production in terms of coal is given for the world and for Europe. England, Germany, and France account for 75% of the European output. Water-power and petroleum are not regarded as formidable opponents of coal. H.H.S.

Burning gas and powdered coal. J. G. CONTANT. *Iron Age*, **119** [6], 419–20 (1927).—C. discusses boiler furnace design for blast-furnace gas and pulverized fuel, separately and in conjunction. A.J.M.

Blast-furnace slag as road building material. P. J. FREEMAN. *Iron Age*, **119** [15], 1060 (1927).—The use of slags in concrete is discussed. A.J.M.

Blast-furnace slag as valuable by-product. W. E. DONALDSON. *Iron Age*, **119** [15], 1061 (1927). A.J.M.

Unit heater for high pressures. ANON. *Iron Age*, **119** [15], 1076 (1927). A.J.M.

Industrial use of steam. C. A. KELSEY. *Iron Age*, **119** [15], 1071 (1927). A.J.M.

BOOKS

Survey of Industrial Welfare in Ontario. FORBES GODFREY. Ont. Dept. of Labor, *Bull.*, 39 pp. (1929).—Industrial welfare is considered under the headings: physical welfare, financial welfare, other plans, and hours of labor. Physical welfare covers accident prevention, health conditions, cafeteria, recreation, holidays with pay, plant publications as propaganda for improved relations and against accident, joint councils and shop committees. Financial welfare covers insurance for sickness and disability, group insurance, pensions and annuities, bonus and profit-sharing, savings plans, and sale of stock to employees. Other plans include stabilization of employment through planning output in advance, the study of wages in other industries, loans for buying houses, etc. Hours of labor are a 48-hour week for 74% of employees, 49 to 54 hours for 22%, and 55 hours or over for 4%. An appendix table shows 300 firms divided according to industrial groups with the number of employees, male and female. Clay, glass, and cement plants number 2% of the whole, and employ 1% of the workers, none female. H.H.S.

The Profession of Engineering. D. C. JACKSON AND W. PAUL JONES. 133 pp. John Wiley & Sons, Inc., New York, 1929. Price $1.50.—Hoover writes on the engineer's contribution to modern life, Hammond on electrical and chemical engineers, Peele on mining, Swain on civil, and Barrus on mechanical engineering. H.H.S.

Mechanical Engineers' Handbook. ROBERT T. KENT. 10th ed. 2247 pp., illustrated. John Wiley & Sons, Inc., New York, 1929. Price $6.00 and $7.00 (leather) in one vol., $8.00 (leather) in 2 vols. H.H.S.

Technical Writing. T. A. RICKARD. 2nd ed., 337 pp. John Wiley & Sons, Inc., New York, 1929. Price $2.00.—Practical advice for the improvement of expression, based on a long editorial experience. H.H.S.

Engineering English. J. H. SCOTT. 321 pp. John Wiley & Sons, Inc., New York, 1929. Price $2.75. H.H.S.

The Construction of Alignment Charts. G. W. SWETT. 92 pp., illustrated. John Wiley & Sons, Inc., New York, 1929. Price $2.00.—It is often difficult to procure a chart for a particular problem. S. presents a direct method of procedure for the construction of charts for equations of various forms. H.H.S.

Vest-Pocket Handbook of Mathematics for Engineers. L. A. WATERBURY, G. A. GOODENOUGH, AND H. H. HIGBEE. 3rd ed. 278 pp., illustrated. John Wiley & Sons, Inc., New York, 1929. Price $2.00. A book containing standard formulas and logarithms. H.H.S.

Proceedings of the International Congress on Testing Materials at Amsterdam, 1927. 2 vols., illustrated. Martinus Nijhoff, The Hague, Holland, 1929. Price 30 guilders ($12.00).—Contains 28 papers in English, 27 in French, and 41 in German. H.H.S.

Materials Handbook. GEORGE S. BRADY. McGraw-Hill Book Co., 1929, 428 pp. $4.00.—A reference book on abrasives, metals and alloys, building materials, fibers,

textiles, paints, chemicals, oils, minerals, and woods used in industry. The materials, arranged alphabetically, are briefly described, with some indications of their properties and uses. A valuable feature is the inclusion of many new proprietary alloys. F.P.H.

Harvard Business Reports. Compiled by Graduate School of Business Administration Harvard University. A. W. Shaw Co., New York. 554 pp., $7.50. Reviewed in *Min. and Met.*, **10** [268], 223 (1929).—The cases in this volume of business reports are all concerned with industrial marketing. They report the actual experiences of various concerns with problems of sales organization advertising, sales promotion, pricing, distributing channels and related matters. Commentaries on each case are given by the editors. F.P.H.

Dollars and Sense. CHARLES E. CARPENTER. 256 pp. Published by Doubleday, Doran & Co., Inc., Garden City, N. Y. Reviewed in *Abrasive Ind.*, **10** [4], 40 (1929). E.P.R.

A Picture of World Economic Conditions. Vol. I. Published by National Industrial Conference Board, N. Y. 119 pages, $2.00 postpaid. Reviewed in *Abrasive Ind.*, **10** [4], 40 (1929).—To meet the broadening and deepening of American interest in foreign countries, following developments of international trade and finance, the National Industrial Conference board has initiated a series of volumes to present the economic status of leading countries. Conditions in the principal countries of the world are reviewed, based on special information received from foreign correspondents of the board and other authoritative sources. E.P.R.

Finding and Stopping Waste in Modern Boiler Rooms. ANON. Reviewed in *Arch. and Bldg.*, **61** [1], 36 (1929). Edited by George H. Gibson, Philadelphia; Cochrane Corp., 804 pages, illustrated. Price $3.00.—This is a reference book of text, tables, and charts compiled from papers read before engineering societies, technical periodicals, and other original sources. The five sections are on fuels, combustion, heat absorption, boiler efficiency and testing, and feed water heating. E.P.R.

Accounting and Cost Finding for the Chemical Industries. GEORGE A. PROCHAZKA, JR. McGraw-Hill Book Co., New York, Price $3.00.—As long as article cost depends on process costs, material costs, etc., chemists and chemical engineers will need some system of cost accounting. Few technical men are really at home in this work. Many manufacturers and chemists will find that this book meets a real need. Reviewed in *Can. Chem. Met.*, **13** [2], 52 (1929). E.J.V.

Mining Year Book, 1929. WALTER S. SKINNER. London, 1929. 904 pp. 20*s.* 9*d.* Reviewed in *Min. and Met.*, **10** [268], 222 (1929).—The book contains data on 1642 mining companies, nearly all British, which are engaged in mining all sorts of minerals in all parts of the world. Statistical tables, a directory of manufacturers, and a list of company officials and of mining engineers are included. F.P.H.

Mechanical World Year Book. Published by Emmott & Co., Ltd., Manchester, England. 348 and 166 pages, 50¢. Reviewed in *Abrasive Ind.*, **10** [4], 40 (1929).—This annual publication has been enlarged by addition of new sections, with all the former chapters retained, brought to date by changes and additions. Helical springs are treated in an effort to eliminate many calculations usually necessary. Fly-wheel proportions and compressed air sections have been added. Tables have been added on mild steel tubes, wire ropes for cranes, and valve end rods. E.P.R.

1929 Yearbook of the Czechoslovakia. Edited by BOHUSLAV HORAK. 316 pp., map, and illustrations. "Orbis," Fochova 62, Prague, 1929. Price $1.80.—Reviewed in *Chem. News*, **138**, 206–207 (1929).—This book is recommended to all seeking information concerning central Europe. H.H.S.

Book Review

Economic Outlook for the Basic Industries of Pennsylvania. A *Bulletin* recently issued by the School of Mines and Metallurgy of Pennsylvania State College, State College, Pa.

The object of the bulletin is to show the high relative value of the mineral industries of Pennsylvania and to show the necessity for greater emphasis in training technical men in the four departments of the school, in order to carry forward these industries and to maintain for the state its prominent position in the mineral industries.

Pennsylvania produces about one-fifth of the total value of the nation's mineral wealth, and in many of the mineral industries it is by far the largest producer among all the states. It shows further, that the mines and products from minerals account for about two-thirds of the entire productive wealth of the state. The primary mineral industries including mining, quarrying, oil and gas production, metallurgy, ceramic and nonmetallic industries, coal processing and oil refining employ over six hundred thousand men or 43% of the total in productive industries of the state. These industries have capital invested to the extent of two and one-half billion dollars or 34% of the capital of productive industries. The total annual pay roll of these industries is about one billion dollars or 48% of the total industrial pay roll.

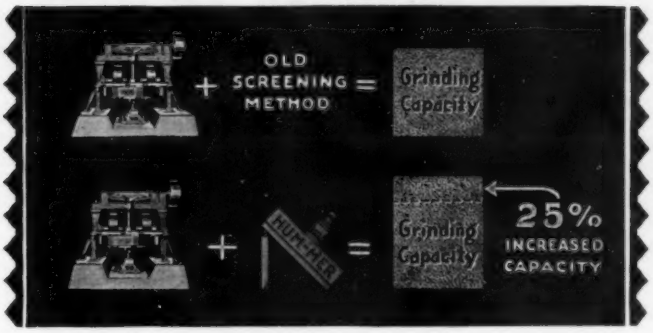
After reviewing the relative value of these industries a survey of the students in the technical schools being trained to carry on their development shows a rather striking deficiency in the number of men being so trained. For instance, while the mineral industries represent 40% of all the industries of the state, the number of students being technically trained to carry on the development is only 6.3% of the total students in technical schools. A further comparison of Pennsylvania's rank, with 33 other states, shows that whereas N. and S. Dak., for instance have seventy students for each ten million dollars of primary mineral products, Pennsylvania has 2.4% students. This table shows that Pennsylvania ranks twentieth among the states in number of students being trained in technical courses compared with the value of industries they are to serve. The whole survey indicates very clearly the need for great increase in the training of technical men to supply these industries in Pennsylvania.

The School of Mines at Penn State is proceeding to correct this obvious deficiency by organizing Advisory Boards for all departments in the school. These Boards are composed of prominent men in the industry who have demonstrated their interest in the school, and expressed their willingness and desire to further the program of training technical men by developing intimate contacts between the departments and the industries which they represent.

It is believed the active coöperation of these Advisory Boards will result in marked improvement not only in the character of the training the men receive in the four departments but also in supplying the students with an objective and giving them a more definite understanding of the specific problems confronting them as they enter the industry.

It is expected that in the near future Advisory Boards composed of men representing other phases of ceramics will be organized and with their active coöperation the department will become a large factor in the future development of the ceramic industries of the state.

See also *Bull. Amer. Ceram. Soc.*, **8** [4], 89 (1929). J. B. SHAW



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TWENTY-FIVE per cent increased output from a 9-foot dry pan by simply replacing their old type screen with the modern Hum-mer Electric Screen.

That is the result reported by the ceramic engineer of a fire brick manufacturer.

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Ceramic Educational Directory

THE OHIO STATE UNIVERSITY

Department of Ceramic Engineering, COLUMBUS, OHIO

Curriculum—Ceramic engineering and technology. Advanced research in co-operation with State owned plants and Federal Government

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS

Founded 1895 *Research Professor:* GEORGE A. BOLE

NEW YORK STATE SCHOOL OF CLAYWORKING AND CERAMICS

ALFRED UNIVERSITY, ALFRED, NEW YORK

Curriculum—Ceramic Engineering, Ceramic Chemistry, Applied Art

SEVEN INSTRUCTORS *Founded 1900* *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS

Department of Ceramic Engineering *Founded 1905* URBANA, ILLINOIS

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE

Department of Ceramic Engineering, AMES, IOWA

Curriculum—Ceramic Engineering major, Ceramic Technology and Pottery subordinate

THREE INSTRUCTORS *Founded 1906* *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA

Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Founded 1910* *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON

Department of Ceramic Engineering, SEATTLE, WASHINGTON

Curriculum—General ceramic engineering with research in ceramics and non-metallics

Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON *Founded 1918* *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN

SASKATOON, SASK.

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Founded 1921* *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE

Department of Ceramics, School of Mines and Metallurgy

STATE COLLEGE, PENNA.

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW *Founded 1923*

GEORGIA SCHOOL OF TECHNOLOGY

ATLANTA, GEORGIA

CERAMIC DEPARTMENT — *Curriculum*—Ceramic Technology and Engineering
TWO INSTRUCTORS — *Founded 1923* — *Director:* A. V. HENRY

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE & ENGINEERING

RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923 — *Curriculum*—Ceramic Engineering
TWO INSTRUCTORS — *Head of Department:* A. F. GREAVES-WALKER

WEST VIRGINIA UNIVERSITY

MORGANTOWN, W. VA.

Ceramic option course founded 1924

Curriculum—Chemical and engineering principles applied to ceramic manufacture
TWO INSTRUCTORS AND TWO ASSISTANTS — *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO

TORONTO, CANADA

Founded: University, 1827; Department of Metallurgy, Ceramic Division, 1925

Curriculum—Ceramic Engineering and Technology
TWO INSTRUCTORS — *Principal Instructor:* ROBERT J. MONTGOMERY

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Vol. 8 **June, 1929** **No. 6**

EDITORIAL

SEARCH AND RESEARCH

BY CHARLES F. BINNS

ABSTRACT

Individual investigation is discussed and suitable laboratory operations are described and explained in detail. The minimum of equipment is presumed.

Introduction

Research

The term "research" is by custom reserved for the type of investigation of which the object is a contribution to the sum of human knowledge. It is usually undertaken by a trained observer who is familiar with and skilled in the manipulation of laboratory processes, and it consists in the exploration of a field either only partially surveyed or entirely unknown. The possibility of practical or financial value does not enter directly into consideration. It is true that in many instances, results have accrued which have proved to be of inestimable importance; that discoveries have been made which have contributed enormously to the comfort and safety of human life and that from these, large financial gains have been realized, but these are not the motives which prompt true research.

Search There is another field, however, and one accessible to the interested investigator who may not be qualified to undertake the effort described above. For convenience and contrast this may be called "search." Search may be considered as an effort to extend one's own knowledge of a subject. It is based, in part, on information supplied by previous workers but it proceeds without regard to the question of an original effort. It aims, not at the extension of human knowledge, but at the information of the searcher, himself. There are many workers in the field of ceramics to whom some guidance in experimentation may be of value and these lines are written in the hope that to these a small service may be rendered.

Many artists and art lovers are tempted by the idea of producing pottery. They recognize in clay the ideal medium for self-expression but they also acknowledge that the art of decorative ceramics involves far more than the shaping of a plastic form. There are complications of colors and glaze and the mystery of the kiln. There is the ever-present risk of loss and the unavoidable fact that the last word always rests with the fire.

Equipment Required for Pottery Search

No one should embark on the endeavor without counting the cost and securing the minimum of equipment. A kiln is indispensable. Taxile Doat says that a ceramist can no more work without a kiln, than a violinist without a bow. Several types of kilns are available and most of them are good. They are adapted to different fuels and this is often the ruling consideration. A kiln fired with kerosene must have a strong draft and therefore a good chimney. Burners using fuel oil are available but a power blower is necessary and for these as well as for gas-firing no more than a simple escape flue is provided, thus avoiding the expense of a chimney. Gas is ideal but not always available. The temperature attainable governs the kind of work to be attempted. The portable type of kiln reaches only the low temperature at which faience can be produced. Beautiful results are accomplished at this temperature by many workers but the limitations are strict. Special mixtures of clays must be used and the glazes must be quite fusible.

The studio may be any convenient room. It should be well lit by day or night and of course, furnished with heat and water. Electrical power is desirable but not indispensable. Power is used for wheels, mills, and compressed air, but at first, none of these will be called for. There should be floor space for half a dozen large bins or covered containers. Barrels or ash cans are good and are easily obtained. On suitable shelves there will be about a dozen tin cans with covers, of the type known as drug cans. Wide mouth glass bottles will contain the more valuable oxides which are used only in small quantities. Corks are better than stoppers

which often stick and are easily broken. Glass fruit jars are not good. The covers are always falling and breaking. Correct weighing is of vital importance. A good pair of counter scales, sensitive to one tenth of a gram should be provided. The pans should be loose and the smaller weights arranged for on a graduated sliding bar. The metric system should be used as the simplest.

Electrically driven grinding mills are valuable, but glazes can be mixed and partially ground quite well in a Wedgwood mortar. The drawback, naturally, is the necessary expenditure of time and "elbow grease."

Clay mixing can also be done by hand if abundant time be given for soaking. Details of this operation would be out of place here and perhaps tedious. They are given in the textbooks.

Knowledge of Materials as Required by a "Searcher"

One of the chief needs of the worker who is limited by the available temperature of his kiln is a knowledge of blending clays and their associated minerals so as to produce a dense body mass of any desired color. There are some clays which fire to a good red and yield a dense body at cone 04 but few or none of buff or white. Ground flint and feldspar are, of course, available but neither will provide the necessary density. English china clay is the best foundation for a white pottery body but it is low in plasticity and very refractory. A light-colored ball clay, Kentucky or Tennessee, should supplement it or may even replace it if the darker color is not objectionable.

If the body is to accept a glaze without disagreement it must contain from 25 to 30% of flint. What is to be done? There are two substances of which either or both will provide the answer. These are cryolite or kryolith and talc or steatite. Cryolite is a fluoride of sodium and aluminum. It is highly fusible and can be obtained either natural or synthetic in powdered form. Steatite, magnesium silicate, was used in the early English china bodies and was called soapstone, because of its soapy feel. It is known as French chalk.

Suggested Procedure

As the object of this paper is to encourage search, no explicit directions or recipes will be given but a method will be suggested. Suppose that a mixture of china clay, ball clay, feldspar, and flint has been decided upon: This may be prepared in the dry state by a careful powdering of the clays and a thorough mixing. The whole mass should be passed two or three times through a 20-mesh sieve. If a mechanical mixer is available the mix can be made in water and then dried and powdered This is the better way but it involves more time and trouble. A certain portion of

the dry clay body is now weighed and to it are added small quantities of cryolite or steatite. It is best not to use both at first and the quantities are gradually increased.

The several mixtures are made up into small pats and numbered. Some worn out type is good for this. Use a little oil on the type. If the size is to be considered, make the pieces large enough to receive a measured line, about 5 cm. See that all the tests are well dried and set them in the kiln for firing.

After firing, each piece should be tested with a steel point. An old pocket knife serves well for this but the point should be sharp. Note the respective hardness of the pottery and arrange the pieces in the order of their resistance. Make careful notes. Now break off a corner of each specimen and with a good lens examine the fractured surface. With a pen make a small ink blot on the fracture. Note the absorption of the ink. If the addition of the fluxes has been in excess some specimens will show blisters. These should be noted and discarded. The object of the range over which the tests are carried is to ascertain the possible limits of the use of the fluxes at a given fire.

How to Design a Series

A principle which is of great value to the searcher is that of the equilateral triangle. It may be applied to bodies, glazes, and colors and is worked out in the following manner. Suppose one wishes to find out all the possible variations to be derived from three glazes, each of which is of a simple hue, such as blue, red, and yellow. (Colors, being most easily understood, are chosen for the illustration.) A triangle is drawn and each side is divided into a number of equal parts; six is a convenient number. The points are connected by lines drawn parallel to each side, thus dividing the triangle into 21 small triangles each of which represents a mixture or blend. Suppose blue occupies the apex, red the lower left angle, and yellow the other. These are marked: the blue, A, the red, B, the yellow, C. No. 1 will be A, only; then for No. 2, 8 parts of A are mixed with 2 parts of B; No. 3, 8 of A and 2 of C, and so on as shown in the table. The whole triangle is thus covered by a graduated series of colors, each parent furnishing its share in proportion to the amount used. This does not seem easy when described but the table should make it plain.

The quantities are weighed out and each group mixed thoroughly and moistened as required. They can then be set in their respective positions as a triangle on a tile and the whole gamut of possible variations is displayed. If a greater refinement of colors is desired the number may be enlarged to ten or twelve divisions but, of course, the labor is correspondingly greater.

This principle may be applied to any series of trials. In the case of a

body or glaze when a color is not the deciding point the parent members should be chosen for some definite characteristic such as, density, fusibility, texture, etc. Experimenting intelligently and over a wide range in this way saves untold delay and annoyance in firing. If one makes a single test, the period of the firing may be lost if the trial proves unsatisfactory, whereas in the single firing of a series, one or more members are almost sure to afford satisfaction. Further, by the preparation of only three sources the whole possible area may be explored. Interesting results are obtained by using white at one angle and blue and green at the others. Except when white is used the parent colors should be about the same value.

	A(1)	*B*(16)	*C*(21)		*A*	*B*	*C*		*A*	*B*	*C*
1	10	0	0	8	4	4	2	15	2	0	8
2	8	2	0	9	4	2	4	16	0	10	0
3	8	0	2	10	4	0	6	17	0	8	2
4	6	4	0	11	2	8	0	18	0	6	4
5	6	2	2	12	2	6	2	19	0	4	6
6	6	0	4	13	2	4	4	20	0	2	8
7	4	6	0	14	2	2	6	21	0	0	10

Tools Required by Pottery Searcher

The tools of experiment are important. Good work cannot be done without system and each tool has its proper use. Spatulas or palette knives, 8 or 10 inches long, glass slabs, bowls, and sponges are indispensable. A water bottle as is used in a chemical laboratory provides a means for adding water drop by drop when needed.

An old magazine printed on glossy paper should be cut up so that each mixture may be weighed on to a separate sheet. It is wrong to weigh out several batches on the same paper. This seems obvious and yet the caution has proved necessary.

Careful marking is important. A small amount of black underglaze color is mixed with water and mucilage, using a little glycerine to prevent drying out. This is kept in a wide mouth bottle with a small camel hair brush. Marking should be systematic, using numbers with or without key letters. Arbitrary marks are soon forgotten and the aim should be to make the marks intelligible even after a lapse of years. Often one picks up a trial and finds that it could be used to advantage but the record cannot be found.

A word on the technique of weighing may not be out of place. Repeated observations have shown that many workers will neglect the simplest directions and will use almost any tool that comes handy. The scales, which have already been mentioned, are fitted with leveling screws and care should be taken that these are properly used so that the beam hangs level both toward front and the sides. The weight on the slide increases toward the right, so that the weights are always placed in the right hand pan. Squares of smooth paper of equal weight may be used, one in each pan, but if the pans themselves are kept clean and bright this is not neces-

sary. For the larger quantities a tin scoop is best. The material must never be poured from the can or the fingers used to make adjustments. A little experience will show how much should be taken on the scoop for 50 grams. For the wide mouth bottles which contain the oxides and colors a steel spatula is necessary. The weight being adjusted, the bottle is held in the left hand and the spatula is inserted into the bottle, taking up a suitable amount of material. Placing this in the left-hand pan the swing of the needle is noted. Small adjustments are made by taking off or adding with the tip of the spatula. If the blade is held steadily it may be tapped gently with the right forefinger, thus causing small quantities, even minute particles, to fall. The material remaining on the blade can then be neatly returned to the bottle. The pan is cleanly emptied onto the waiting paper and so on until the weighing is completed.

If the batch is to be ground on the mill, no mixing is necessary but otherwise and especially for a mixture which is to be fritted, there must be a thorough mixing. A sieve of, at the largest, 20-mesh should be used, as lumps are likely to escape even the mixing in a mortar. After using the sieve repeatedly, effective mixing may be done on a large sheet of smooth paper. The batch is placed in the center and a side of the paper is lifted in either hand. The mass can then be rolled backward and forward until the blending is complete.

If one does not own a grinding mill, glazes can be prepared in a Wedgwood mortar as already stated, but there is a correct method of doing this. Too much material must not be attempted at one time. If the whole batch of glaze is weighed out and mixed dry as described above, it may be ground in the mortar a part at a time. A beginning may be made with about one hundred grams. This amount is placed in the mortar and the water added little by little and with continued working of the pestle until the mass is the consistency of a thick paste. It should cling to the surface of the mortar and the sides of the pestle, flowing gently, but without any tendency to slop. Too much water will prevent successful grinding because the material cannot stay between the two surfaces. Every movement of the pestle must find a portion of the glaze between it and the mortar wall. A slow circular motion is kept up until the glaze paste seems smooth. It is then scraped out into a bowl and another portion is treated. Some glazes can be diluted and passed through a sieve but if fine materials have been used this is rarely necessary. An exception is when calcined clay has been used as is often necessary in a matt glaze. The calcined clay must be finely ground before use.

The mortar method is best for alkaline glazes. The soluble salt present cannot be properly ground on a mill because much of it is lost in the washing.

NEW YORK STATE SCHOOL OF CLAYWORKING AND CERAMICS
ALFRED, N. Y.

PAPERS AND DISCUSSIONS

PORCELAIN MAKING IN CHINA[1]

A New Turn to an Old Art

By J. S. Leibson

ABSTRACT

A brief description is given of the history of Chinese porcelain and of the methods and materials used by the Chinese at the present time in their manufacture of art and service porcelains. Reference is made to a factory in Shanghai, China, manufacturing dry-process electrical porcelain under American methods.

Introduction

History According to Chinese history, the art of pottery making was highly developed in China some three thousand years before the Christian era, although porcelain as it is known today, dates back to the Han Dynasty from 206 B.C. to 25 A.D. It was during this period that the Chinese discovered the necessary ingredients and invented the process of working them to make the ware called porcelain.

No authentic specimens of Chinese porcelain of a period earlier than the Sung Dynasty (960 to 1279 A.D.) are known to exist, but even at this period it is most remarkable how the Chinese, working with such crude and variable ceramic raw materials, were able to manufacture a product of such translucency and artistic quality that today it is to be marveled at and it is reproduced only with great difficulty.

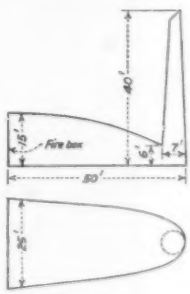


FIG. 1.—Chinese porcelain kiln.

The early porcelains were made almost exclusively for the Imperial families, although as far back as 1280 A.D. when Marco Polo visited the southern part of China he reported that porcelains were being exported to various parts of the world.

Porcelain manufacture was given its greatest impetus during the Ming Dynasty from 1368 to 1644 A.D. when great strides were made with new colors and new designs. Up to this time there were no decorations, all porcelains being covered with a plain white glaze having a bluish tinge, due evidently to firing under reducing conditions.

Additional impetus was given during the Manchu Dynasty by the emperors who took a fancy to porcelain so that we find extraordinary strides made during the reign of Kang Hsi from 1662 to 1723 and during the reign of Chien Lung from 1736 to 1791.

In 1920, some 2000 years after the birth of porcelain, the materials used

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (White Wares Division.) Received January 4, 1929.

in the manufacture of the precious Ming vases were finding a new use in the manufacture of electrical wiring devices in Shanghai.

Present Manufacturing

Porcelain is manufactured today in a number of provinces throughout China, the most important districts which I had the opportunity of visiting in 1920 being in Kiangsi, Fukien, and Hunan Provinces.

With the exception of one factory, the Hunan Porcelain Company at Liling, Hunan Province, there was no semblance of any mechanical power employed in any of the porcelain factories. Unfortunately, I did not have the opportunity of seeing this Liling factory in operation as only a short time previous, several wings of the factory were destroyed during the fighting between the Northern and Southern Chinese soldiers. I did see,

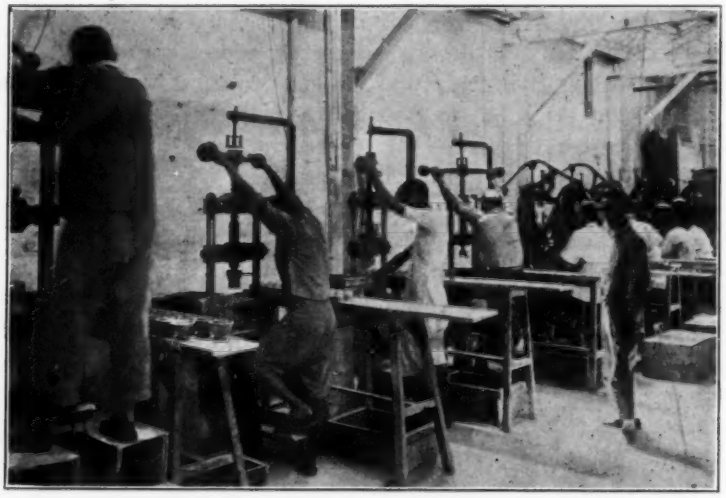


FIG. 2.—Pressing dry-process electrical porcelain.

however, the remains of a small steam power plant, jaw crushers, ball mills, lathes, etc. The ware manufactured by the Hunan Porcelain Company was by far the best quality manufactured in Hunan Province although it did not compare with the best grades manufactured in China.

In the district of Tehwa, Fukien Province, ware of excellent quality, comparing favorably with the best Chinese porcelains, are now manufactured only on a small scale although the industry flourished here at one time. There are several other districts in Fukien where porcelain is made, but the ware is of rather poor quality.

By far the most important district for the manufacture of Chinese porcelain is that in the city of King-Teh-Chin in Kiangsi Province, the porcelain center of China for the past thousand years. Of its 200,000 inhabitants,

practically 150,000 are engaged either directly or indirectly in the manufacture and marketing of porcelain. With possibly the single exception of the Kiangsi Porcelain Co., no single manufacturer in King-Teh-Chin includes all the operations of forming, firing, and decorating in his own factory. As a general rule one manufacturer will form and glaze his ware and then rent space in a kiln belonging to another for the firing. He will then sell his plain white glazed porcelain to the decorators.

Kaolin Used

Chinese porcelain is made essentially from a primary kaolin and a ma-

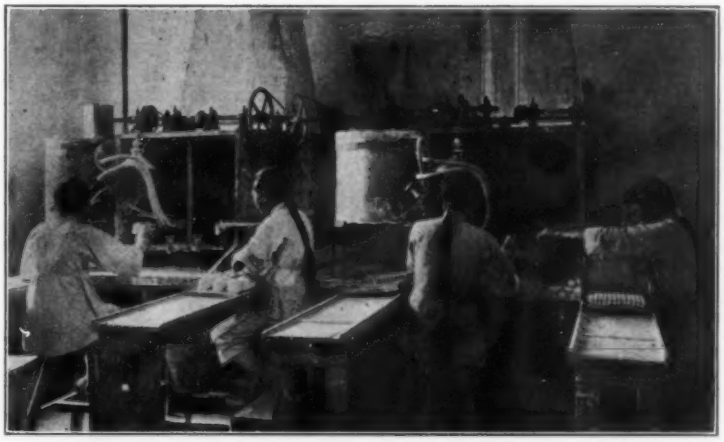


FIG. 3.—Glazing booths.

terial known as pe-tun-tse, formed by pulverizing a white firing felsitic rock. Searle gives the molecular formula of Chinese porcelains as

$$0.40 \text{ to } 0.5RO(Al_2O_3)5.5 \text{ to } 6SiO_2$$

with an average chemical composition as:

	(%)
SiO_2	70.0
Al_2O_3	22.2
Fe_2O_3	1.3
Na_2O	2.7
K_2O	3.6
CaO	0.8
	100.6

The kaolin used in the finest King-Teh-Chin porcelains originally came from the district of Kaoling in Kiangsi Province, and it was from the name of this district that our English word "kaolin" was derived. With the growth of the industry, however, new deposits were located and today most

of the kaolin for King-Teh-Chin comes from Sin Tse in Kiangsi Province.

The kaolin is transferred to a pit, mixed with water and passed through a series of settling troughs to remove coarse particles. The partially refined clay slip is then run into settling tanks where the supernatant water is drawn off, and the thick slip transferred to drying pits lined with porous brick. When dried to the proper consistency, the kaolin is molded into bricks weighing about five pounds each, stamped with the name of the miner and shipped to King-Teh-Chin.

The pe-tun-tse rock is mined both in open quarries and by driving tunnels into the hillsides, depending of course on the extent of the overburden. The best grades of pe-tun-tse are jade-green in color, brittle, and transparent on thin edges while the poorer grades are found in various stages of decomposition down to a soft white rock than can be crushed between the

FIG. 4.—Assembling wiring devices.

fingers. A chemical analysis of pe-tun-tse is given in G. P. Merril's Non-Metallic Minerals as:

	(%)
SiO_2	73.55
Al_2O_3	21.09
CaO	2.55
MgO	0.15
Ignition loss	2.62
	99.96

The selected rocks are reduced by hand hammers to about two-inch cubes and delivered to the pulverizing plants located along the hillside following the course of a stream. The pulverizing is accomplished by stamping for 24 hours in a mortar and pestle pulverizer with power derived from a water-wheel. The mortar is made of granite holding a charge of fifty pounds, while the pestle which drops about forty times per minute

is made of wood and capped with a porcelain disk. An average pulverizing plant contains 24 mortars and turns out about 1200 pounds of crushed rock per day.

The pulverized material is made into a thin slip in an open air pit, stirred by hand with wooden paddles, passed through a settling trough and finally molded into brick similar to the method employed in the preparation of kaolin brick.

Due to the lack of adequate rail transportation, the Chinese depend almost entirely on their network of waterways for transporting clays. In certain districts the streams are so shallow that the Chinese resort to bamboo rafts capable of holding a load of only 1000 pounds of clay brick.

In other districts, where waterways are not available, it is not uncommon for the clay to be transported by wheelbarrow or suspended from a bamboo pole on the shoulder of a coolie on a journey lasting two or three days.

At the factories the kaolin and one or more varieties of pe-tun-tse, or perhaps one or more varieties of pe-tun-tse without any kaolin, are blended into wooden vats, the coarse particles are permitted to settle, and the slip containing the fine particles transferred to another vat. This refining is repeated a number of times, depending on the quality of ware desired, after which the refined mix is allowed to settle, the clear water drawn off, and the thick slip transferred either to saggers for drying to the proper consistency for the potter's wheel, or into cloth bags weighted with stones so as to form a filter press.

The plastic mix is then kneaded with bare feet, permitted to age for a day or two, and finally delivered to the potter for spinning his ware.

Manufacture of the Ware

The potter's wheel is mounted on porcelain bearings and receives its momentum from the potter, who either by placing a stick in a hole near the circumference starts the wheel spinning, or else kicks it around with his feet. After spinning, the ware is air dried, placed again on the potter's wheel, and turned down to the desired size and shape.

The glaze, which the Chinese refer to as the flesh of the porcelain, the body representing the bones, is applied by dipping, spraying, or painting with a brush, depending on the shape of the piece to be glazed, and the effect desired.

The atomizer most commonly used for spraying is nothing more than a small bamboo tube covered at one end with a layer of fine cloth. The covered end of the tube is dipped into the glaze so as to allow a small amount of the liquid to filter into the tube, which is then held close to the work and the glaze is blown out as a fine spray.

For the crudest types of ware, children are employed to paint a simple

underglaze decoration on the raw ware. For the better class of ware, men are employed in decorating.

With large vases of complicated design, it is not unusual for a skilled craftsman to spend weeks and even months completing one piece.

Naturally, the formulas of bodies and glazes are carefully guarded, and handed down from generation to generation by father to son.

All the colored oxides were formerly obtained in China, but now the more modern manufacturers resort to the purer oxides obtained principally from Germany and Japan. Due to the absence of mechanical grinders, the colors are ground by hand with a mortar and pestle, a process requiring several days for the grinding of a few pounds of colored frit.

White glazes are made from the best grades of pe-tun-tse, softened by additions of limestone and alkalis from the ashes obtained by firing certain varieties of ferns.

FIG. 5.—Cleaning dry-process porcelains.

After being glazed, the unfired porcelains are carried to the kilns where space is rented for the ware to be fired. As might be expected, the choice parts of the kiln where there is the least danger of being overfired or underfired, command the highest prices.

The saggers in which the porcelain is fired are made in special factories and sold to the ware makers. The sagger wall is made by cutting a strip of the plastic sagger mix from a block, wrapping it around a collapsible circular form, and kneading the ends of the strip together on a potter's wheel. The bottom of the sagger is pressed into a steel ring and joined to the sagger wall by kneading with the fingers.

Wood is used as a fuel and of the 125 kilns in King-Teh-Chin, about 100 burn the wood from pine trees. The kilns are about 50 feet long with a combination wicket and fire box at one end and a chimney about 40 feet high at the other end. The width of the kiln at the fire box end is about

25 feet, but this narrows down to about 7 feet toward the chimney end. Firing is completed in about 36 hours, at a temperature of approximately 1400°C. The Chinese fireman depends almost entirely on his eye to determine the kiln temperature, and as a result, kiln losses are frequently very high. Evidence of kiln losses is seen in the mountains of scrap and in the porcelain lined river beds around porcelain manufacturing districts.

At the unloading of a kiln, the various ware makers are around to claim their porcelains which they identify by marks on the saggers and also by the trademarks on the porcelains themselves.

FIG. 6.—Updraft potter's kiln.

Electrical Porcelain in China

With this background of China's five thousand years of pottery production and the excellence of Chinese art and service porcelains, the writer was called upon to introduce the production of electrical porcelain, a new phase of an old art brought into existence by one of the most modern and gigantic of industries, electrical apparatus manufacture. This introduction of electrical porcelain was started in Shanghai in 1920.

Naturally the specific requirements of electrical porcelain production are somewhat different from those of the art and service porcelains made for so many years in China.

After being accustomed to thinking of electrical porcelain in terms of ball clay, china clay, flint, and feldspar, it was somewhat disturbing at first to be reduced to practically nothing but kaolin and pe-tun-tse as body

materials. The Chinese materials, however, were found suitable for the manufacture of electrical porcelain and satisfactory dry-process bodies were developed using approximately 20% kaolin and 80% pe-tun-tse. The fine grinding of the pe-tun-tse gave it sufficient plasticity to correspond to the plasticity of a mixture of plastic ball clay and nonplastic quartz and feldspar so that the final porcelain body was found to mold quite well in steel dies. Due to the numerous disturbing elements throughout China cutting off sources of supply, it was found necessary to change formulas rather frequently.

The porcelain mixture was prepared in a blunger, passed through a 120-mesh vibrating screen and then filter pressed at a pressure of 80 pounds per square inch as compared to the Chinese method of stirring the mix by hand with wooden paddles, removing the coarse particles by repeated settlings, and removing the excess water by drying in saggers.

The filtered cakes were dried in a steam drier, moistened with the necessary amount of water required for dry-process work, and then passed through a pulverizer, a method quite unknown to the Chinese.

For pressing the porcelain parts, screw presses operated by men were used for the heavier porcelains, while lever presses operated by women were used on smaller work.

After drying in a steam-heated drier, the dry porcelains were cleaned and then glazed by spraying in mechanically-driven glazing booths. Although the atomizers were operated with compressed air, the principle of spraying was the same as that of the old Chinese atomizer made of a bamboo tube previously described.

The glaze formula corresponded to the formula of Seger cone 4, using Chinese limestone, kaolin, and quartz, and Japanese feldspar, ground together in a ball mill.

The ware was fired in 36 hours to cone 10 in an updraft potter's kiln using Japanese coal as fuel. Temperature measurements were taken with Seger cones in addition to a recording pyrometer with thermocouples in three parts of the kiln. The introduction of a pyrometer was quite an innovation in the history of porcelain making in China as the usual practice of the Chinese fireman in determining temperatures was to spit on a porcelain disk built into the wall of the kiln and to observe how the spit rebounded. This disk was exposed to the heat in the kiln and reddened as firing progressed.

With brass parts imported from America, wiring devices of American design were assembled on the Chinese-made porcelains primarily for Chinese consumption.

General Electric Company
Schenectady, N. Y.

ACTIVITIES OF THE SOCIETY

BRITISH CERAMISTS VISIT AMERICA

They came April 28. They said they crossed the sea westward as comfortably as "live trout in a lime basket." They left us May 18. We hope none will cross the sea eastward by rail.

While here not one of the 58 was indisposed, maimed, or made languid notwithstanding the "one night stand tour" with a banquet plus at each place.

They expected to find braggarts here; instead they found American ceramists willing to let their plants, processes, and products speak for themselves; and plenty they did tell if the comments of the Britishers are correctly interpreted.

Courteous, intelligent, and accustomed to success were the British and they caused Americans to act their best.

Hotel Pennsylvania, New York.

A fair exchange of information, a sure cementing of friendships and plans for working together resulted from this visit. These are worth today all that they cost in effort and money to obtain and they will accrete themselves many fold with passing time.

We wish them to have an album of those who entertained them. We regret that we are less than 50% successful in the compiling of this album.

May these visits be continued. They are profitable.

Roof Garden—Hotel Pennsylvania, N. Y.

English Ceramists Land Safely

A cablegram addressed to George A. Bole, President, AMERICAN CERAMIC SOCIETY, was received in Columbus, May 29.

Meltham Silica Firebrick Co., Ltd.,
Meltham, nr. Huddersfield,
England.

From homeland greet you and your members in happy memoirs of our wonderful trip.

(Signed) W. J. GARDNER, *President*
Ceramic Society of England.

New York Reception Committee

DR. E. ORTON

Twenty years Secretary, American Ceramic Society. Dean of Ceramic Education in the United States; Standard Pyrometer Cone Co., Columbus, Ohio.

E. V. ESKESEN

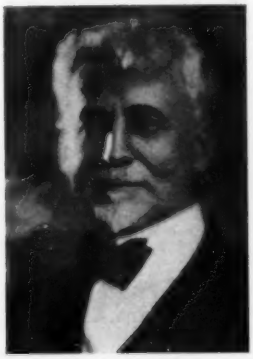
President, Federal Seaboard Terra Cotta Co., New York City. Chairman, New York Committee.

G. H. BROWN

Director, Ceramics Department, Rutgers University, New Brunswick, N. J. Secretary N. J. Clay Workers Association. Chairman, Committee on Programs, British Ceramic Tour. Past President, American Ceramic Society.

MACDONALD C. BOOZE

Past President, American Ceramic Society. Chas. Taylor & Sons Co., Cincinnati, Ohio.



ROSS C. PURDY

Secretary, American Ceramic Society, Columbus, Ohio. Director, British Tour in America.

GEORGE A. BOLE

President, American Ceramic Society. Secretary, Ohio Ceramic Industries Assn.

F. A. CARDER

Vice-President and Manager, Steuben Division, Corning Glass Works, Corning, N. Y.

W. K. MCAFEE

President, Universal Sanitary Mfg. Co., New Castle, Pa. President, Ohio Ceramic Industries Association.

J. M. MCKINLEY

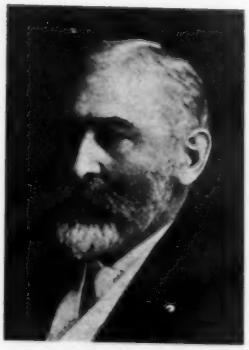
President, American Refractories Institute. Vice-President, North American Refractories Co., Cleveland, Ohio. Trustee, American Ceramic Society.

HAROLD F. DINGLEDINE

President, Canadian National Clay Workers Association. Production Manager, National Sewer Pipe Co., Ltd., Hamilton, Ont., Canada.

B. MIFFLIN HOOD

Past President, American Ceramic Society. B. Mifflin Hood Brick Co., Atlanta, Ga.



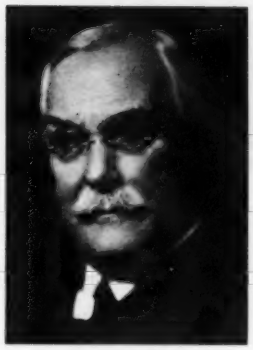
C. A. BLOOMFIELD

Founder of Ceramic Education in New Jersey, Metuchen, N. J.

New Jersey Committee

D. P. Forst

Manager, Robertson Art Tile Works, Morristown, N. J. Past President, N. J. Clay Workers Association. Chairman, Trenton Committee, British Tour Program.



John A. Campbell

Pres. The Trenton Potteries Co., Trenton, N. J.

F. A. Whitaker

General Superintendent, General Ceramics Co., Keasbey, N. J.

R. L. Clare

Past President, American Ceramic Society. Seaboard Federal Terra Cotta Co., Woodbridge, N. J.

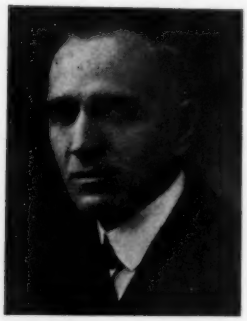
George Simcoe

Edgars Plastic Kaolin Co., Metuchen, N. J.

C. W. Crane

Crossman Co., South Amboy, N. J.

D. Wm. Scammell
Scammell China Co., Trenton, N. J.



A. Foltz
President, Lambertville Pottery Co., Lambertville, N. J.

C. F. Geiger
The Carborundum Co., Perth Amboy, N. J.

Leslie Brown
Lenox, Inc., Trenton, N. J.

A. Staudt
President, Perth Amboy Tile Works, Perth Amboy, N. J. Division of Rossman Corp.

Baltimore-Philadelphia Committee

E. C. Hill
Member, Board of Trustees, American Ceramic Society. Conkling-Armstrong Terra Cotta Co., Philadelphia, Pa.

L. J. Trostel
Chief Chemist, General Refractories Co., Baltimore, Md. Chairman, Refractories Division, American Ceramic Society.

W. J. Stephani
Mgr., O. W. Ketchum Terra Cotta Works, Crum Lynne, Pa.

E. DEF. CURTIS

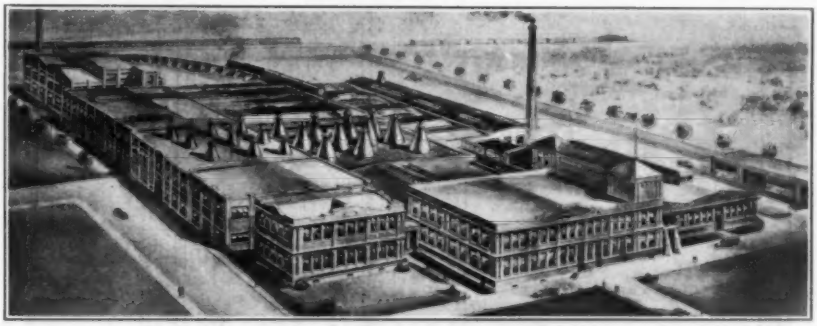
Member, Board of Trustees, American Ceramic Society. Philadelphia Museum of Industrial Art, Philadelphia, Pa.

B. T. SWEELY

Member, Board of Trustees, American Ceramic Society. Baltimore Enamel and Novelty Co., Baltimore, Md.

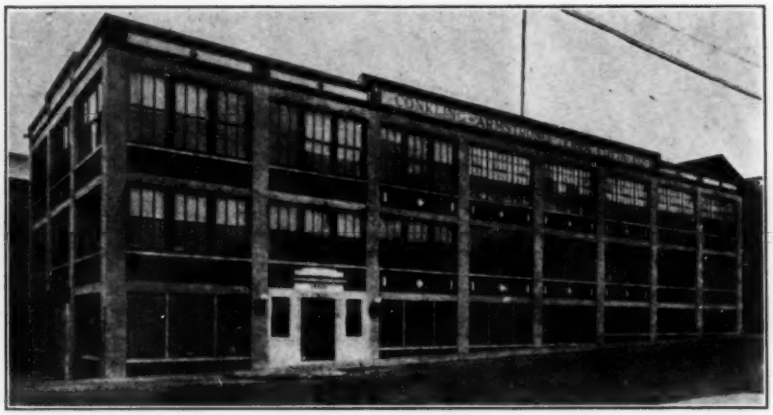
R. F. GELLER

The Abrasive Company, Philadelphia, Pa.

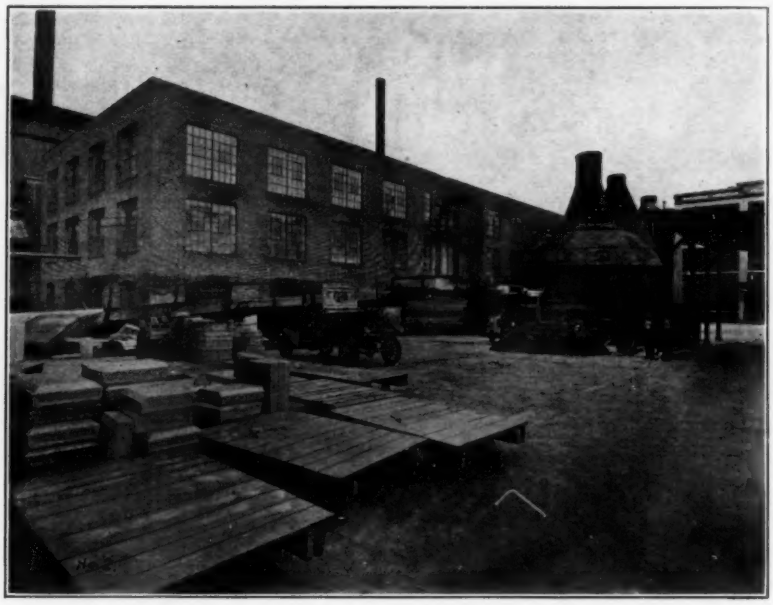


Abrasive Co., Bridesburg, Philadelphia, Pa.

Thomas F. Armstrong, Pres., Conkling-Armstrong Terra Cotta Co., Philadelphia, Pa.



Factory Office and Studio, Conkling-Armstrong Terra Cotta Co., Philadelphia, Pa.



Interior Yard, Conkling-Armstrong Terra Cotta Co., Philadelphia, Pa.

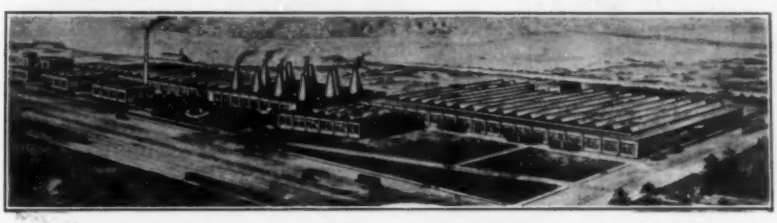
LOCKE INSULATOR CORPORATION

Locke porcelain was first marketed in 1894. For 35 years Locke engineers, with every facility for research, have striven to improve both material and design and to determine from study of operating conditions, the particular design best fitted to given loads and climatic conditions.

The Locke plants at Baltimore, Md., and Victor, N. Y., have a combined capacity of 40 kilns.

The plant reception committee included K. A. Hawley, chief engineer, W. A. Weldon, D. H. Rowland, H. O. Jensen, Clarence Springer, R. McCoy, J. A. Robertson, and Oscar Christensen.

Front row, left to right: John A. Le Mieux, James F. Toy (Gen. Mgr.). Back row, left to right: E. L. Crosby, H. G. Cooper, Walter Harvey, J. M. Weaver.
Locke Insulator Corp., Baltimore, Md.



Locke Insulator Corporation, Baltimore Plant.

GENERAL REFRACTORIES COMPANY

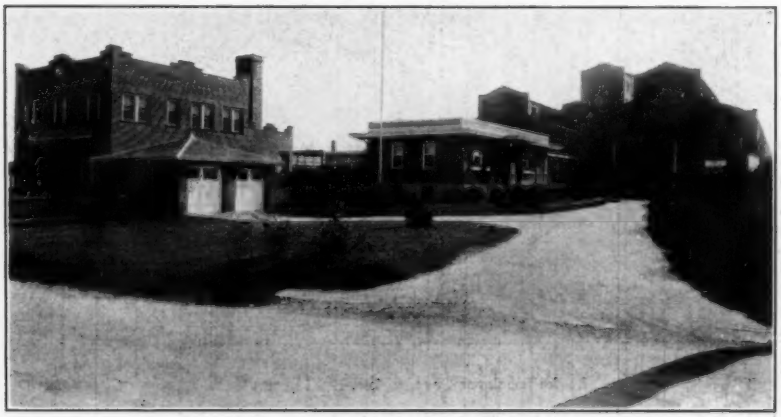
Founded in 1911, the company has steadily increased in size until now it is the second largest company producing refractories in the United States.

The company operates 15 plants manufacturing fire clay, silica, diaspore, magnesite, chrome, and acid-proof brick as well as several high temperature cements.

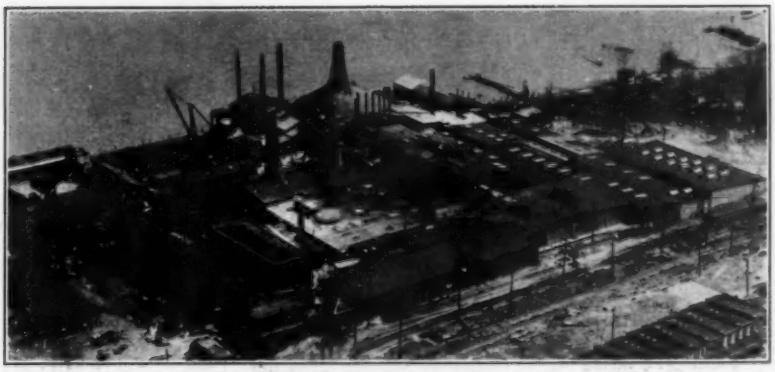
The Baltimore plant manufactures magnesite and chrome brick exclusively and a high temperature chrome cement. This works is located at the port of Baltimore in order that advantage may be taken of the excellent harbor facilities. A greater part of the raw materials is imported and an appreciable tonnage of the finished product is exported.

At the Baltimore works is located the central research and testing laboratories of the company. These laboratories are equipped with very modern and advanced types of apparatus for carrying on physical, chemical, and microscopic research on the company's varied line of refractory products.

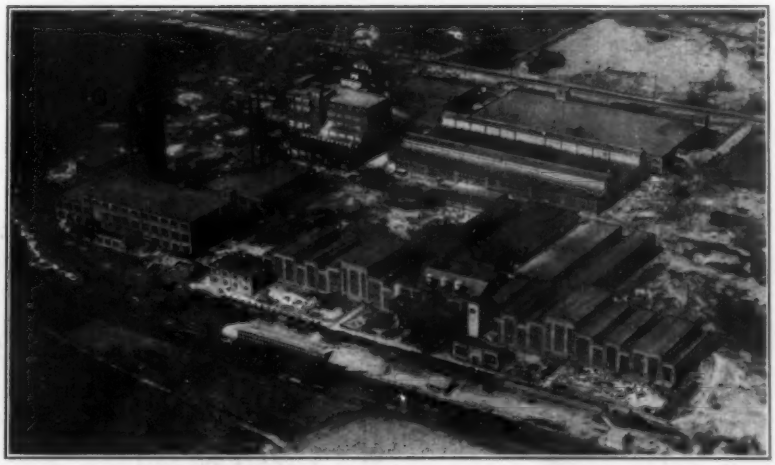
L. J. Trostel, A. W. Anson, J. C. Hanawalt, M. L. Bell, R. P. Heuer.
General Refractories Co., Baltimore, Md.



General Refractories Co., Baltimore Works.



Carr-Lowrey Glass Company, Baltimore, Md.



Standard Sanitary Mfg. Co., Baltimore Works.

Washington Committee

G. K. BURGESS

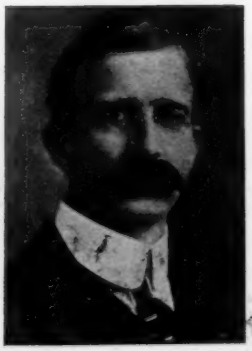
Director, Bureau of Standards, Washington, D. C.

R. A. HEINDL

Refractories Investigation, Bureau of Standards, Washington, D. C. Chairman, Washington Committee.

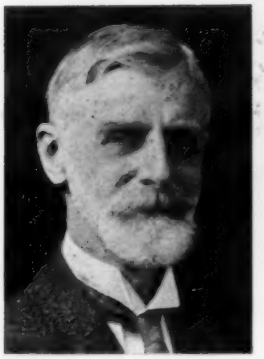
H. G. SCHURECHT

Research on Terra Cotta, Bureau of Standards, Washington, D. C.



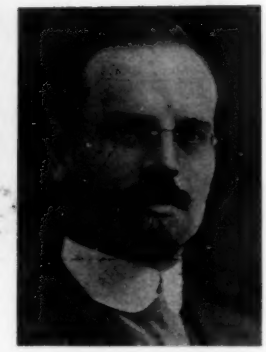
R. T. STULL

Bureau of Standards, Washington, D. C. Past President, American Ceramic Society.



K. LANGENBECK

616 McGill Bldg., Washington, D. C. Past President, American Ceramic Society.



DR. E. W. WASHBURN

Chief, Division of Chemistry, U. S. Bureau of Standards, Washington, D. C.

Pittsburgh Committee

MELLON INSTITUTE OF INDUSTRIAL RESEARCH

Mellon Institute, the System of Practical Coöperation between Science and Industry, was conceived in principles laid down by Robert Kennedy Duncan for the creation of new knowledge by scientific investigation. The institution was founded by Andrew W. and Richard B. Mellon, whose constant interest has contributed in large measure to its success.

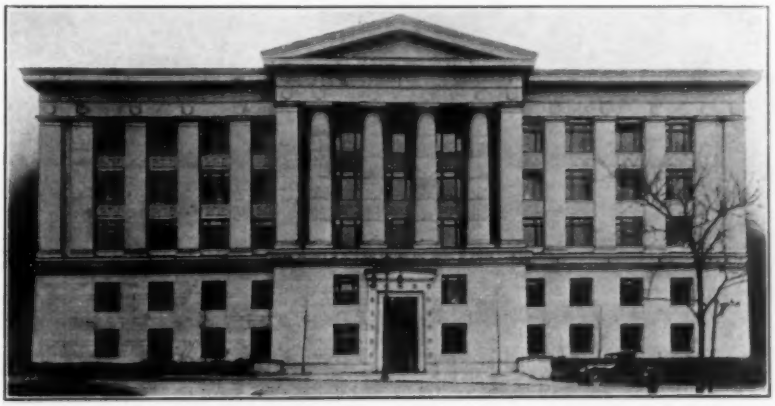
The objects of Mellon Institute are (1) coöperation between science and industry, to bring to industries the benefits of the latest developments of scientific research; (2) establishment for scientists of an adequate medium for self-expression through provision of facilities for research; (3) beneficence to humanity by additions to the mass of human knowledge.

The Industrial Fellowship System is organized on a contract basis, the problem being proposed by a person, company, or association. The scientist to carry on the investigation is engaged by the Institute for a period of at least one year. The results obtained belong exclusively to the donor and only one investigation is carried out on a particular subject at any one time.

The Institute is primarily an industrial experiment station, but its organization is such that the Fellows are enabled to obtain a broad training in research methods and in special subjects of technology. The Department of Pure Research, a most important part of its activities, is devoted to the prosecution of research not suggested by industry, but planned as a background and source of stimulus for industrial research.

This year, the eighteenth since the establishment of the Institute at Pittsburgh, the total funds paid by Fellowship donors, including both companies and associations, in support of investigations was $800,083.58, an increase of $98,399.39 over the payments of last year. The number of scientists on Fellowship problems has increased to 173. The total number of publications during the calendar year 1928 was 159, including 25 U. S. patents.

At the close of the fiscal year, 62 distinct problems were under investigation. The problems in ceramics and related fields in operation during the year 1928–29 include the following Fellowships: composite glass, enamels, flat glass, foundry practice, glass production, insulating glass, Portland cement, refractories, silicate, slag, and vitrified sewer pipe.



Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

E. R. WEIDLEIN

Director, Mellon Institute, Pittsburgh, Pa.

A. SILVERMAN

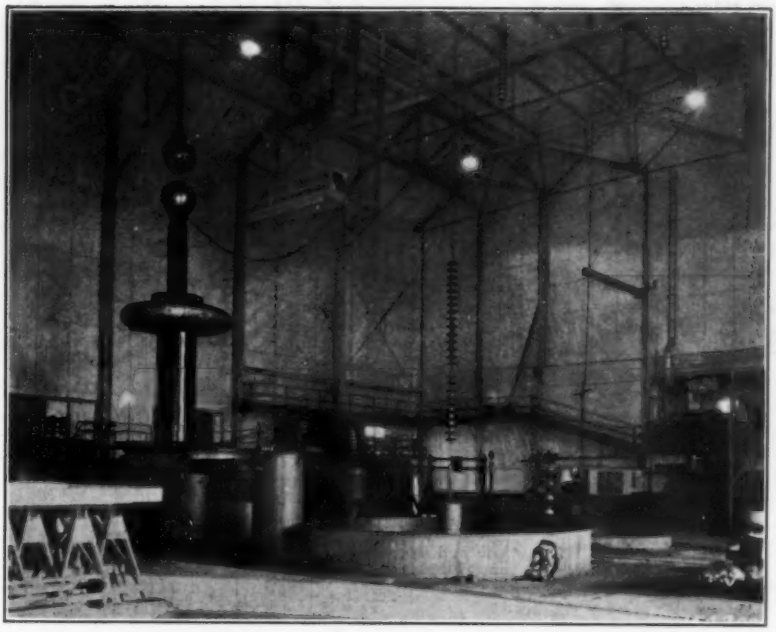
Head, Dept. of Chemistry, Univ. of Pittsburgh, Pittsburgh, Pa. Chairman, Western Pennsylvania Committee.

E. W. TILLOTSON

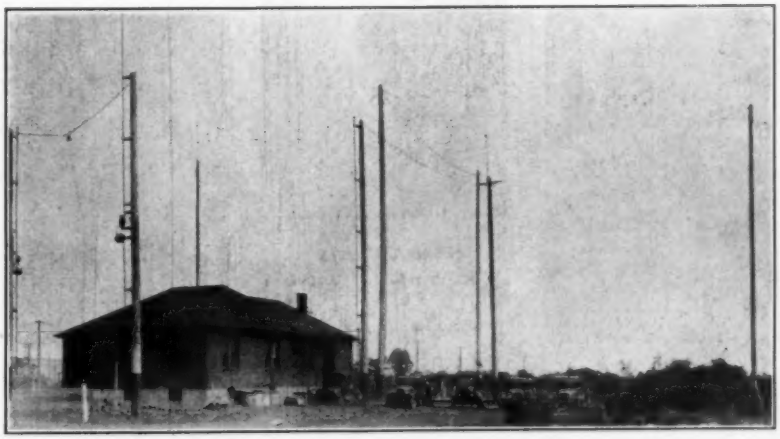
Past President, American Ceramic Society. Assistant Director, Mellon Institute, Pittsburgh, Pa.

Pittsburgh Station U. S. Bureau of Mines.

Westinghouse Research Laboratory, East Pittsburgh, Pa.



A general view of the laboratory interior at Westinghouse Electric Co., East Pittsburgh, Pa.



KDKA, Pioneer broadcasting station of the world, Westinghouse Electric Co., East Pittsburgh, Pa.

H. M. KRANER

Westinghouse Electric & Manufacturing Co., E. Pittsburgh, Pa.

S. M. KINTNER

Manager, Research Laboratories, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

E. H. FRITZ

Works Manager, Derry Plant, Westinghouse Mfg. Co., Derry, Pa.

J. E. LEWIS

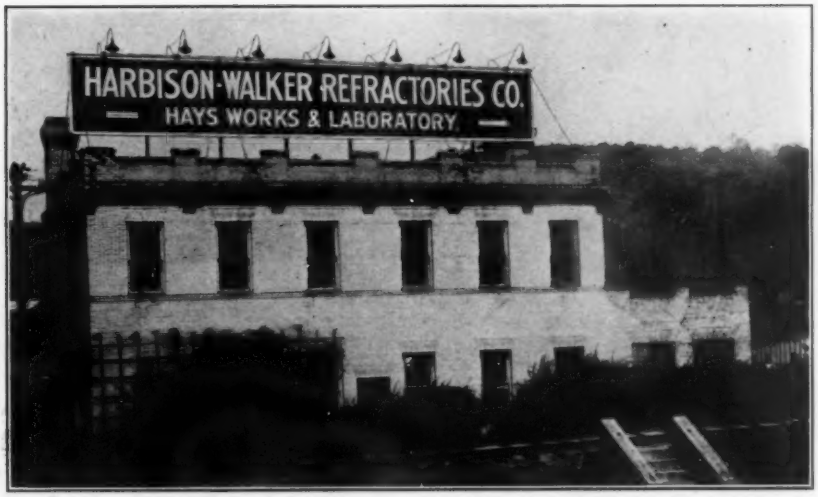
President, Harbison-Walker Refractories Co., Pittsburgh, Pa.

FRED A. HARVEY

Vice-President, American Ceramic Society. Research Engineer, Harbison-Walker Refractories Co., Pittsburgh, Pa.

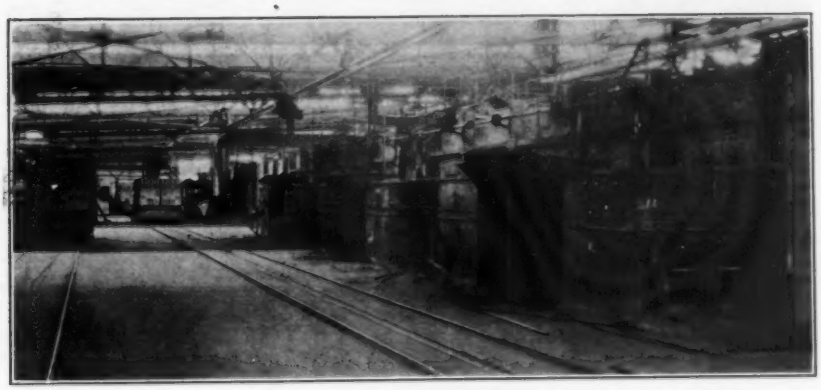
KENNETH SEAVER

Sales Manager, Harbison-Walker Refractories Co., Pittsburgh, Pa.

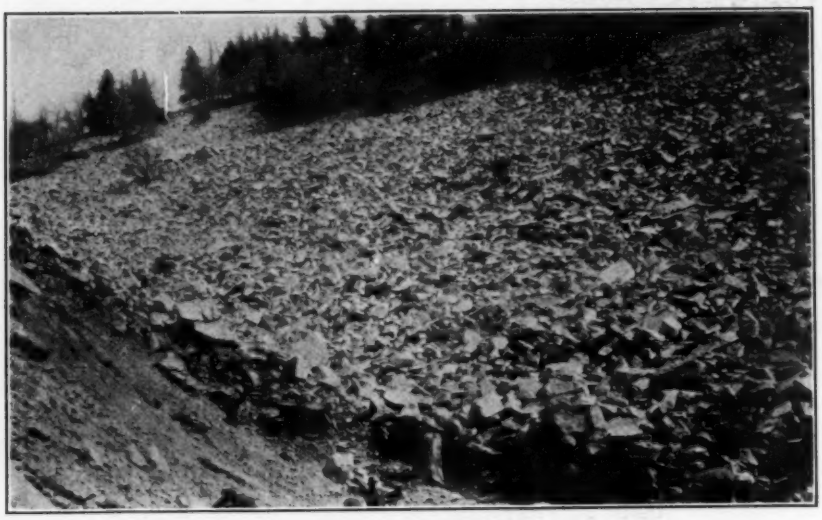


Control Laboratory of Harbison-Walker Refractories Co., Hays, Pa.

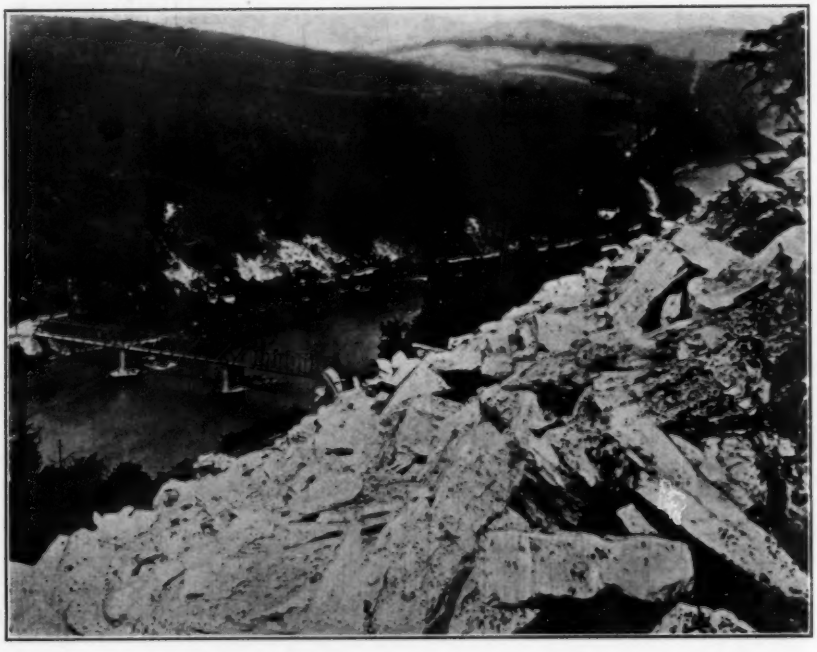
Silica brick plant at Mt. Union, Pa.
Harbison-Walker Refractories Co.



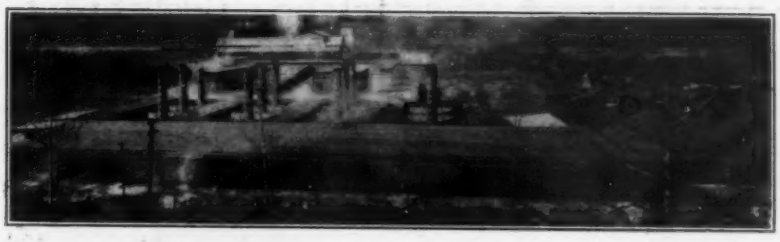
Kiln room interior—tunnel kiln at Harbison-Walker Refractories Co., Clearfield, Pa.



Ganister quarry near Mt. Union, Pa.
Harbison-Walker Refractories Co.



Ganister flow with view of Juniata River, near Mt. Union, Pa.
Harbison-Walker Refractories Co.



Mount Union Plant, U. S. Refractories Corp.

U. S. Refractories Co., Mt. Union Plant.

B. E. WHITESELL

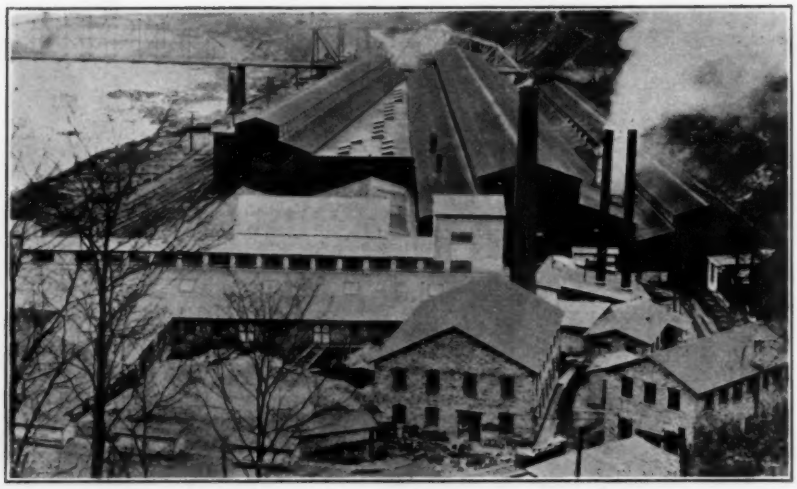
Ceramic Engineer, Kier Fire Brick Co., Pittsburgh, Pa.

J. SPOTTS MCDOWELL

Director of Research, Harbison-Walker Refractories Co., Pittsburgh, Pa. Reception Comm., Western Pennsylvania Committee.

A. W. KIMES

President and Editor, *Glass Budget*, Pittsburgh, Pa.



Kier Fire Brick Co., Salina, Pa.

Layout and Storage Platforms, Kier Fire Brick Co., Salina, Pa.

Lancaster Brick Co., Lancaster, Pa.

Lancaster Iron Works, Lancaster, Pa.

Beaver Falls, Pa., Committee

BEN D. HARDESTY

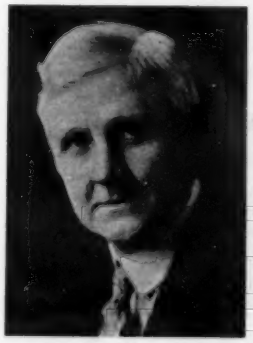
Superintendent, Mayer China Co., Beaver Falls, Pa. Chairman, Beaver Falls Committee.

F. W. WALKER

Chairman of Board, Rossman Corporation, Beaver Falls, Pa. Past President, American Ceramic Society.

ARTHUR E. MAYER

President, Mayer China Co., Beaver Falls, Pa.



J. M. SMITH

President and Treasurer, Shenango Pottery Co., New Castle, Pa.

WALTER S. MAYER

Vice-President, Mayer China Co., Beaver Falls, Pa.

J. B. SHAW

Prof. of Ceramics School of Mines, Pennsylvania State College, State College, Pa.

R. A. HORNING

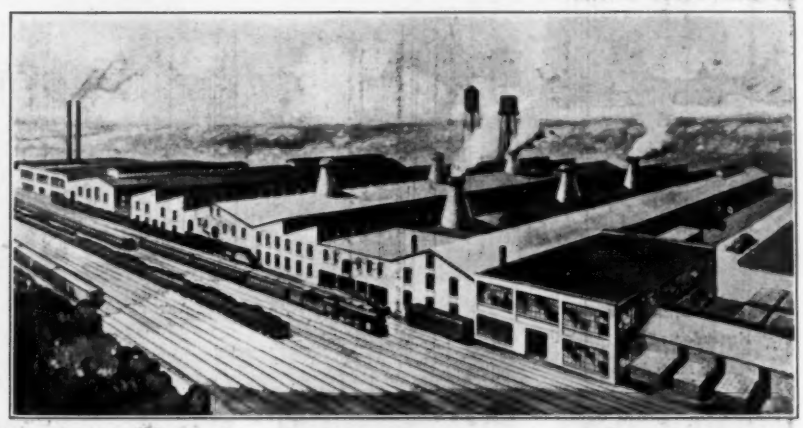
Manager, Armstrong Cork Co., Beaver Falls, Pa.

LOUIS INGRAM

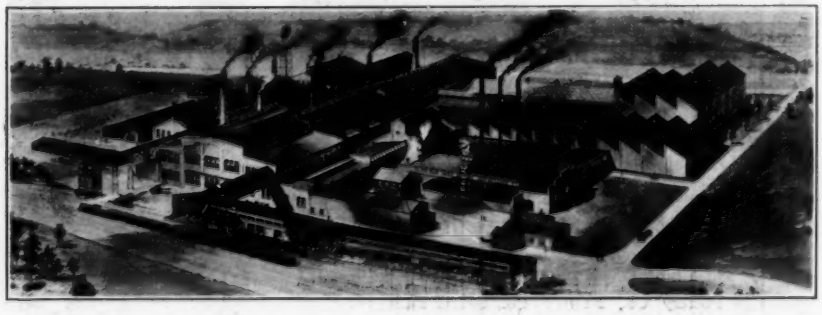
President, Ingram-Richardson Mfg. Co., Beaver Falls, Pa.

P. D. HELSER

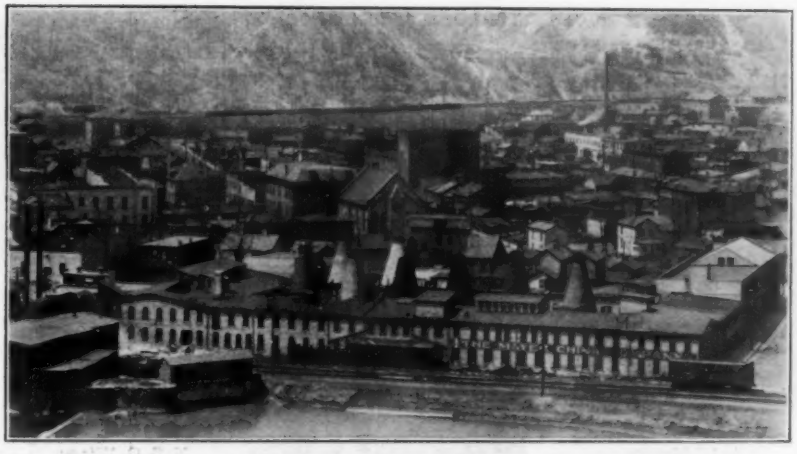
Vice-President, Eljer Company, Ford City, Pa.



Universal Sanitary Mfg. Co., New Castle, Pa.



Ingram-Richardson Mfg. Co., Beaver Falls, Pa.



Mayer China Co., Beaver Falls, Pa.

East Liverpool, Ohio, Committee

ERNEST RICHARDSON

Vice-President and Treasurer, Ingram-Richardson Mfg. Co., Beaver Falls, Pa.

W. A. WELLS

General Manager, Homer Laughlin China Co., Newell, W. Va.

A. V. BLEININGER

Director of Research, Homer Laughlin China Co., Newell, W. Va. Past President, American Ceramic Society.

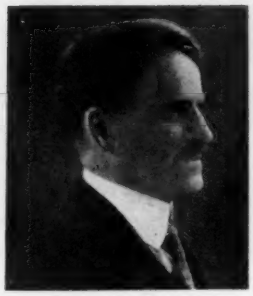
F. H. RHEAD

Homer Laughlin China Co., Newell, W. Va.

St. Louis Committee

A. M. MENZIE

Secretary, Missouri Refractories Assn., St. Louis, Mo.



F. E. BAUSCH

Engineering Equipment, St. Louis, Mo., Chemical Bldg. Chairman, St. Louis Section, American Ceramic Society.

N. S. C. WALSH

Vice-President, Mississippi Glass Co., Refractories Division, St. Louis, Mo.

J. H. MCKELVEY

Vice-President, Laclede-Christy Clay Products Co., St. Louis, Mo.

W. J. WESTPHALEN

Vice-President and General Manager, Laclede-Christy Clay Products Co., St. Louis, Mo.

T. M. PIERCE

Counsel, Missouri Refractories Institute, St. Louis, Mo. and Wabash R. R.

J. L. GREEN

President, Laclede-Christy Clay Products Co., St. Louis, Mo.

L. C. HEWITT

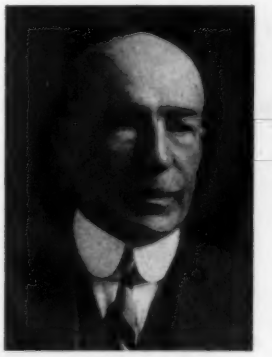
Laclede-Christy Clay Products Co., St. Louis, Mo.

CHARLES W. PARKER

General Manager, Mississippi Glass Co., Refractories Division, St. Louis, Mo.

J. E. TAUSSIG

President, Wabash R. R., St. Louis.



W. C. MAXWELL

Vice-President in Charge of Traffic, Wabash R. R., St. Louis.

R. M. SIEVERS

District Sales Mgr., Harbison-Walker Refractories Co., St. Louis, Mo.

J. L. CRAWFORD

Ceramic Engineer, Laclede-Christy Clay Products Co., St. Louis, Mo.

CLARENCE H. KING

President, Evens and Howard Fire Brick Co., St. Louis, Mo.

G. W. JONES

Secretary-Treasurer, Evens and Howard Fire Brick Co., St. Louis, Mo.

County Plant of Evens and Howard Fire Brick Co., North and South Roads, Clayton, St. Louis County, Mo.

Mexico and Farber, Mo., Committee

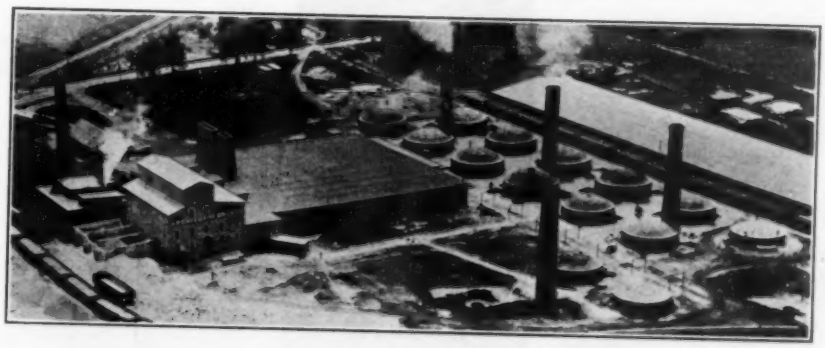
A. P. GREEN

President, A. P. Green Fire Brick Co., Mexico, Mo.

J. B. ARTHUR

Vice-President, A. P. Green Fire Brick Co., Mexico, Mo.

A. P. Green Plant No. 1, Mexico, Mo.



A. P. Green Plant No. 2, Mexico, Mo.

D. H. KREUTZER

Treasurer, A. P. Green Fire Brick Co., Mexico, Mo.

H. B. PLUNKETT

Sales Manager, A. P. Green Fire Brick Co., Mexico, Mo.

J. HARRISON BROWN

Secretary, A. P. Green Fire Brick Co., Mexico, Mo.

C. O. McNAMEE

General Manager, Fulton Fire Brick Co., Fulton, Mo.

M. E. HOLMES

Professor, Ceramics, Missouri School of Mines, Rolla, Mo.

L. U. NICKELL

President, Fulton Fire Brick Co., Fulton, Mo. "Uncle Luther" is the Dean of Missouri Fire Brick Manufacturers.

Farber Plant, North American Refractories Co., Farber, Mo.

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J. L. MURPHY

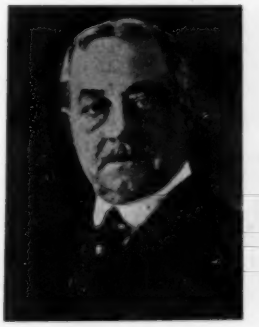
President and General Manager, Nelsonville Brick Co., Nelsonville, Ohio.

G. W. DENISON

Member, Board of Trustees, American Ceramic Society. Vice-President and Gen. Mgr., Ohio Clay Co., Cleveland, Ohio.

T. B. ANDERSON

Manager, Pope-Gosser China Co., Coshocton, Ohio.



C. J. KIRK

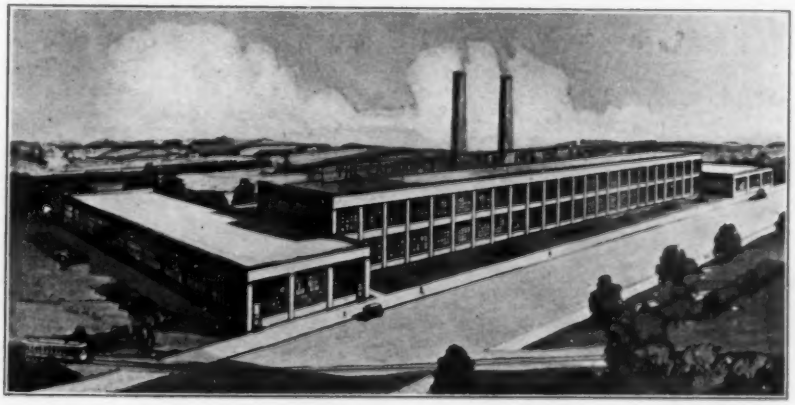
New Castle, Pa., President, Cambridge Sanitary Manufacturing Co., Cambridge, O.

C. L. SEBRING

President and Treasurer, Sebring Pottery Co., Sebring, Ohio.

GEORGE E. FRAUNFELTER

President, Fraunfelter China Co., Zanesville, Ohio.



Cambridge Sanitary Mfg. Co., Cambridge, Ohio.

V. J. ROEHM

Research Ceramist and Engineer, Sebring Pottery Co., Sebring, Ohio.

FRANK M. RANSBOTTOM

Treasurer, Robinson-Ransbottom Pottery Co., Roseville, Ohio.

NELSON MCCOY

President and General Manager, Nelson McCoy Sanitary Stoneware Co., Roseville, Ohio.

Partial View of Plant of National Fire Proofing Co., East Palestine, Ohio.

Office Building, National Fire Proofing Company, East Palestine, Ohio.

R. P. HERROLD

President, Mosaic Tile Co., Zanesville, Ohio.

J. D. MARTIN

Straitsville Impervious Brick Co., New Straitsville, Ohio.

M. H. LINN

President and Gen. Mgr., Zanesville Stoneware Co., Zanesville, Ohio.

GEO. C. EARLE

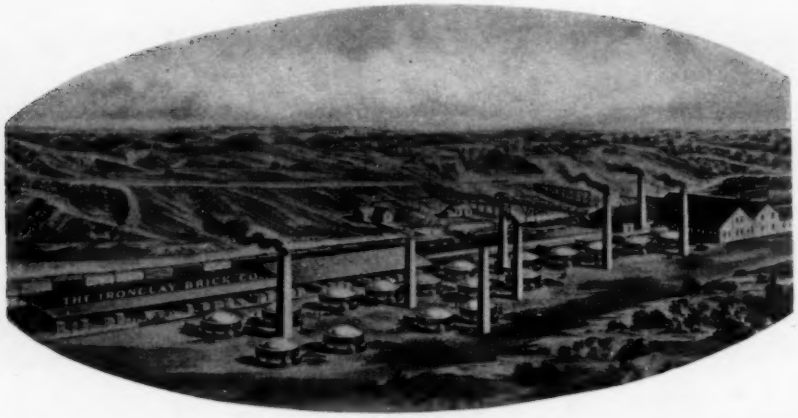
Hydraulic Press Brick Co., Roseville, Ohio.

J. J. F. BRAND

Hydraulic Press Brick Co., Roseville, Ohio.

GUY CROOKS

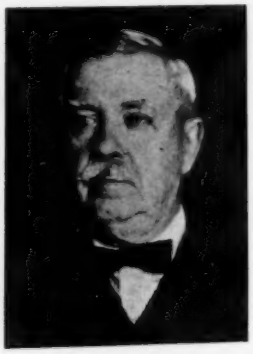
President and General Manager, Crooksville China Co., Crooksville, Ohio.



Ironclay Brick Co. Plant at Shawnee, Ohio.

C. F. TEFFT

General Manager, Claycraft Mining & Brick Co., Columbus, Ohio.

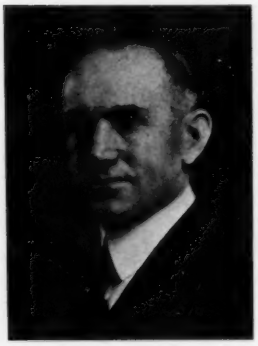


E. LOVEJOY

Consulting Ceramic Engineer, Columbus, Ohio. Past President, American Ceramic Society.

T. A. KLINEFELTER

U. S. Bureau of Standards, Columbus, Ohio.



O. W. RENKERT

President and General Manager, The Metropolitan Paving Brick Co., Canton, O.

R. B. KEPLINGER

Vice-President in Charge of Production, Metropolitan Paving Brick Co., Canton, O.

E. A. STEWART

Manager and Treasurer, The Stark Brick Co., Canton, Ohio.

A. S. WATTS

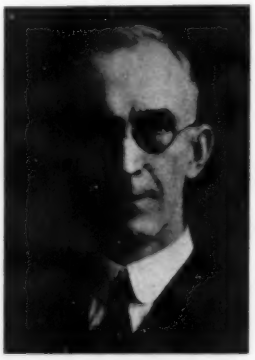
Head, Ceramic Dept., Ohio State Univ., Columbus, Ohio. Past President, American Ceramic Society.

C. B. HARROP

President, Harrop Ceramic Service Co., Columbus, Ohio.

F. M. HARTFORD

Harrop Ceramic Service Co., Columbus, Ohio.



H. B. HENDERSON

Treasurer, American Ceramic Society. Works Manager, Standard Pyrometric Cone Co., Columbus, Ohio.

GEO. S. BRUSH

Vice-President and General Manager, The Brush Pottery Co., Zanesville, Ohio.

E. SCHRAMM

Research Chemist, Onondaga Pottery Co., Syracuse, N. Y.

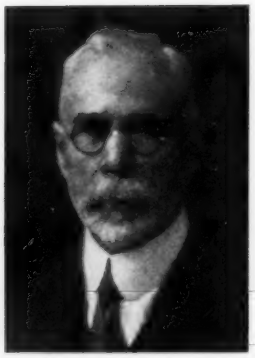
B. E. SALISBURY

President, Onondaga Pottery Co., Syracuse, N. Y.

WM. CANNAN, JR.

Onondaga Pottery Co., Syracuse, N. Y.

Western New York and Canada Committee



C. F. BINNS

Director, New York State School of Clayworking and Ceramics, Alfred, N. Y.

DR. FRANK J. TONE

President, Carborundum Co., Niagara Falls, N. Y.

G. C. KEITH

Secretary, Canadian National Clay Workers Association, 49 Toronto Road, Toronto (10), Canada.

Roster of the Ceramic Society of England Tour in America

H. T. Arrowsmith, J.P., C.C., T. Arrowsmith & Sons, Burslem, Stoke-on-Trent.

Col. Harry Johnson, D.S.O., T.D., J.P., H. &R. Johnson, Ltd. Highgate Tile Works, Tunstall, Stoke-on-Trent.

Joseph Burton, Pilkington's Tile & Pottery Co, Ltd., Clifton Junction, nr. Manchester.

F. C. Johnson, Alfred Meakin Ltd., Royal Albert Potteries, Tunstall, Stoke-on-Trent.

Edward Sadler, Mrs. Sadler, Newlands, Watlands Ave., Wolstanton, Staffs.

Walton Stanley, J.P., 5, Winton Square, Stoke-on-Trent.

Sir William John Jones, K.B.E., Lady Jones, Miss Jones, 17 Victoria Street, Westminster, London, S.W.1.

J. Steventon, Royal Pottery, Burslem, Stoke-on-Trent.

A. V. J. Dennis, 217, King Street, Fenton, Stoke-on-Trent.

Albert H. Carder, C. Carder & Sons, Leys Pottery, Brierley Hill, S. Staffs.

John Adams, Carter, Stabler & Adams, Poole, Dorset.

Björn Holmström, Gefle, Märter Olofsgatan 9, Sweden.

P. B. G. Johnston, Pountney & Co., Ltd., Bristol.

Ronald William Sherwin, H. & R. Johnson Ltd., Tunstall.

H. E. Wood, Doulton & Co. Ltd., Burslem.

J. E. Beswick, John Beswick, Gold Street, Longton, Stoke-on-Trent.

Dr. J. W. Meller, F.R.S., Sandon House, Regent Street, Stoke-on-Trent.

Mrs. Emma Mellor, Sandon House, Regent Street, Stoke-on-Trent.

R. E. Elford, Carter & Co., Poole.

Counsellor Mrs. Henry Wood, Gorsefield, High Lane, Burslem, Stoke-on-Trent.

Miss Lomas, J. & J. Dyson Ltd., Griffs Fireclay Works, Stannington, nr. Sheffield.

Mrs. Grimwade, Fairlands, Trent Vale, Stoke-on-Trent.

Mrs. West, Derbyshire Silica Firebrick Co. Ltd., Friden, Hartington, nr. Buxton.

G. V. Evers, E. J. & J. Pearson Ltd., Stourbridge.

W. J. Gardner, Meltham Silica Firebrick Co. Ltd., Meltham, nr. Huddersfield.

J. E. Benn, The Leeds Fireclay Company Ltd., Wortley, Leeds.

Norman Stein, Mrs. Stein, John G. Stein & Co., Ltd., Bonnybridge, Scotland.

William Herbert Warren, Gas Light & Coke Company, Gas Works, Nine Elms Lane, South Lambeth, S.W.8.

Frank West, M.I.Mech. E., Derbyshire Silica Firebrick Co. Ltd., Friden, Hartington, nr. Buxton.

Russel Mervyn Doidge, B.Sc., F.I.C., Douglas Firebrick Company, Dalry, Aryshire.

Roland Cullinan, The Potteries, Olifantsfontein, Transvaal.

Miss G. Hulme (Dr. Mellor's Secretary), N. S. Technical College, Stoke-on-Trent.

J. Holland, Mrs. Holland, Pickford Holland & Co. Ltd., Eclipse Ganister Works, Attercliffe Road, Sheffield.

Thomas Bottomley Johnston, The Leeds Fireclay Company Ltd, Wortley, Leeds.

Alex. Lomas, F.G.S., F.E.S., J. & J. Dyson Ltd., Griffs Fire Clay Works, Stannington, nr. Sheffield.

Major Edward Stuart Clark, Llay Hall Colliery Co., Llay Hall, nr. Wrexham.

Percy Stuart Devereux, Managing Director, British Abrasive Wheel Co. Ltd., Tinsely, Sheffield.

G. A. Hodson, Hathern Station Brick & Terra Cotta Co., Loughborough.

G. Norman Hodson, Loughborough.

A. H. Stephenson, J.P., Mrs. Stephenson, Globe Brick & Tile Co, Garrison Lane, Birmingham.

Thos. Mosedale, Brickmaker, Davyhulme, Urmston.

Thos. Mosedale, Jr., Davyhulme, Urmston.

Wm. Nock, Mrs. Nock, Holly Lane Brickworks, Erdington, Birmingham.

Fred. C. Stedham, Webber & Stedham, Slate Merchants, Brick & Lime Mfrs., 22 Market Street, Torquay.

NEW MEMBERS RECEIVED FROM APRIL 1 TO MAY 1

CORPORATION

King Machine & Manufacturing Co., 1171 East 32nd St., Los Angeles, Calif., F. Y. Pearne, representative.

PERSONAL

Miguel Alejandro, Apartado de Correos 728, Barcelona, Spain, Consejero Delegado de la Compania Espanola.

Mario Ceresini, 6033 Wentworth Ave., Chicago, Ill.

Jos. S. Gregorius, Research Engineer, Pittsburgh Plate Glass Co., Creighton, Pa.

Joseph F. Klekotka, Ceramic Chemist, Room 215, Industrial Bldg., Bureau of Standards, Washington, D. C.

Walter H. Pink, 14 Ardoven Place, London, Ont., Canada, Foreman of the Enameling Dept., London Foundry Division, General Steel Wares, Ltd.

J. G. Pittenger, Auditor, Homer Laughlin China Co., Newell, W. Va.

Norman W. Welch, 611 Architects Bldg., Los Angeles, Calif., Secretary-Manager, Clay Products Institute of Calif.

Merrill C. Sondles, 618 Taylor Ave., Cambridge, Ohio, Superintendent, Atlas-Globe China Co.

H. L. Stokely, Valley Clay Products Co., Brownsville, Texas.

Waldemar Weyl, c/o Kaiser-Wilhelm-Institute for Silikat-Forschung, Faradayweg 16, Berlin, Germany.

STUDENT

Howard Failmezger, Rutgers University, New Brunswick, N. J.

William W. Meyer, Stanford University, Stanford, Calif.

R. M. Schild, Iowa State College, Ames, Iowa.

Chauncey L. Smith, Rutgers University, New Brunswick, N. J.

Membership Workers' Record

CORPORATION		STUDENT	
F. A. McCann	1	G. H. Brown	2
		W. F. Dietrich	1
PERSONAL		D. A. Moulton	1
A. V. Bleininger	1		—
J. L. Carruthers	1	Total	4
W. M. Cohn	1	Grand Total	15
L. J. Frost	1		
R. A. Heindl	1		
H. R. Straight	1		
Office	4		
	—		
Total	10		

NOTES AND NEWS

NOTES FROM THE CERAMIC SCHOOLS

University of Toronto[1]

The graduating class consists of three men and they have accepted positions as follows:

Thomas Bouckley, with the Canada Gypsum & Alabastine Co., Ltd., Paris, Ont.

M. R. Scriven, with the Cooksville Shale Brick Company, Toronto, Ont.

W. G. Wilson, with the National Sewer Pipe Company, Hamilton, Ont.

The National Sewer Pipe Company is a consolidation of the three sewer pipe plants in Ontario and they are starting a Research Laboratory with Mr. Wilson in charge.

The third-year men will be employed for the summer as follows:

J. M. Higgins will return to the National Fire Proofing Co., Toronto, Ont.

James S. Little will be with the Canadian General Electric Co., in their porcelain plant at Peterboro, Ont.

F. R. Stone will be at the new plant in Montreal being constructed by the Cooksville Shale Brick Co.

H. L. Watts will be with the National Sewer Pipe Company, Hamilton, Ont.

The work of the Department is progressing satisfactorily and through coöperation with the industry we have been able to give employment to all the students who have registered in the course.

Ohio State University

Dr. Spurgeon Bell, of the Bureau of Business Research of Ohio State University, addressed the Student Branch of the AMERICAN CERAMIC SOCIETY at its April meeting on "The Industrial Importance of Ohio and the Distribution of Its Industries."

The students enrolled in ceramic art at Ohio State will in future be eligible to membership in the Student Branch of the AMERICAN CERAMIC SOCIETY, an organization formerly limited to students in ceramic engineering.

Ten junior students in ceramic engineering at Ohio State were elected to membership in "Keramos," Honorary National Ceramic Fraternity. They were: W. K. Carter, Columbus, Ohio; T. L. Falknor, Covington, Ohio; G. A. Hutt, Chillicothe, Ohio; E. C. Seabright, Martins Ferry, Ohio; J. T. Sellers, Wellston, Ohio; S. T. Spires, New Straitsville, Ohio; G. Soler, Columbus, Ohio; H. W. Thiemecke, Pittsburgh, Pa.; G. N. Tuttle, Columbus, Ohio; N. G. Wedemeyer, Columbus, Ohio.

Prof. Wilber Stout, State Geologist, took a group of ceramic engineering students into southern Ohio on April 13 and 14 inspecting fireclay mines, sewerpipe and firebrick plants in that district.

The annual inspection trip to ceramic industries, conducted by the ceramic engineering department of Ohio State University, was conducted during the week April 22 to 27. The trip included 26 plants, at Mansfield, Massillon, Barberton, Akron, Cleveland, Elyria, Tiffin, Toledo, and Detroit. The party consisted of 55 students under the direction of R. M. King, of the Ceramic Engineering Department. On the trip the party was entertained at lunch by The Ohio Insulator Co., Barberton, Ohio, and the Massillon Refractories Co., of Massillon, Ohio. The Ferro Enamel Supply Company, of Cleveland, Ohio, entertained the party with a banquet on the evening of April 24th at the Monoco Restaurant.

---

[1] R. J. Montgomery, Professor of Ceramic Engineering.

A. S. Watts, Professor of Ceramic Engineering, has received some valuable specimens of terra sigillata, an ancient Roman pottery, which were found in burial mounds at Ludwigshafen on the Rhine River, Germany. The process of manufacture is a lost art, and Prof. Watts hopes, through the study of these specimens, to recover the knowledge of the processes involved.

E. L. Harcourt, Ceramic Engineering 1927, who is with the Ludowici Celadon Company, manufacturers of roofing tile in Germany, expects to return to the United States during the coming summer.

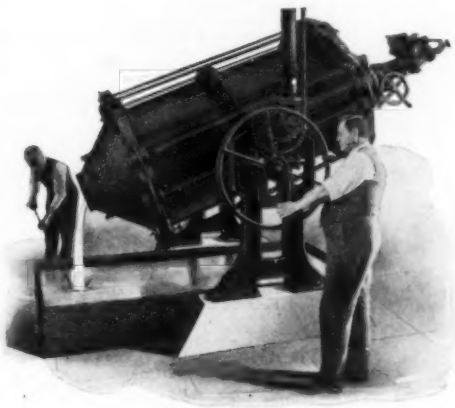
Robert E. Gould, Ceramic Engineering 1925, has been appointed Engineer-Director of the Anaconda Copper Company porcelain plants in Silesia, Poland, and will leave with his family for Europe in June. Mr. Gould has been ceramic engineer for the Taylor, Smith, and Taylor Pottery Company for the past two years and has rebuilt their plants during that time. The potteries of the Anaconda Copper Company are among the largest in Europe.

CALENDAR OF CONVENTIONS

Organization	Date	Place
American Assn. for Advancement of Science	Dec. 27–Jan. 2, 1930	Des Moines, Iowa
AMERICAN CERAMIC SOCIETY	February, 1930	Toronto, Canada
American Gas Association (11th Annual Convention)	Oct. 14–18	Atlantic City, N. J.
American Institute of Chemical Engineers	June 19–21	Philadelphia, Pa.
	Dec. 2–4	Asheville, N. C.
Amer. Inst. Mining & Metallurgical Engineers	Oct. 7–9	San Francisco, Calif.
American Society of Mechanical Engineers	July 1–4	Salt Lake City, Utah
(Annual Meeting)	Dec. 2–6	New York City
American Society for Testing Materials	June 24–28	Atlantic City, N. J.
11th National Metal Exposition and National Metal Congress	Sept. 9–13	Cleveland, Ohio
Natl. Assn. of Manufacturers	Oct. 14–16	New York City
Natl. Glass Distributors Assn.	Dec. 3–5	Pittsburgh, Pa.
Natl. Safety Council's 18th Annual Safety Congress	Sept. 30–Oct. 4	Chicago, Ill.
Third International Foundrymen's Congress	June 10–13	London, England
Twelfth Exposition of Chemical Industries	Week of May 6	New York City

U. S. Rotary Enamel Smelting Furnaces Give

SATISFACTION



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Grand Rapids Refrigerator Co., Grand Rapids, Mich.
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Edison Electric Appliance Co., Inc., Chicago, Ill.
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Ernest Stevens, Limited, Cradley Heath, England.
Ward Leonard Electric Company, Mount Vernon, N. Y.
American Enameled Products Co., Chicago, Ill.
Michigan Porcelain Tile Works, Ionia, Michigan.
Stanley Insulating Company, Great Barrington, Mass.
Roesch Enamel Range Company, Belleville, Ill.
L. D. Caulk Company, Milford, Delaware.

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Innis, Speiden & Co.
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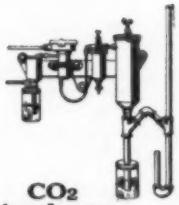

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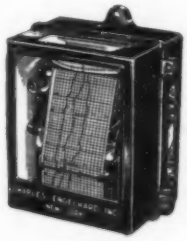

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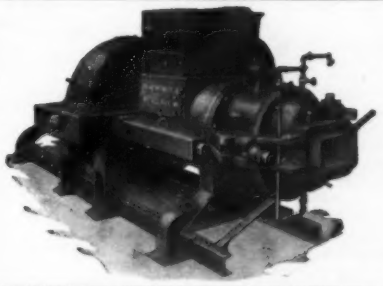

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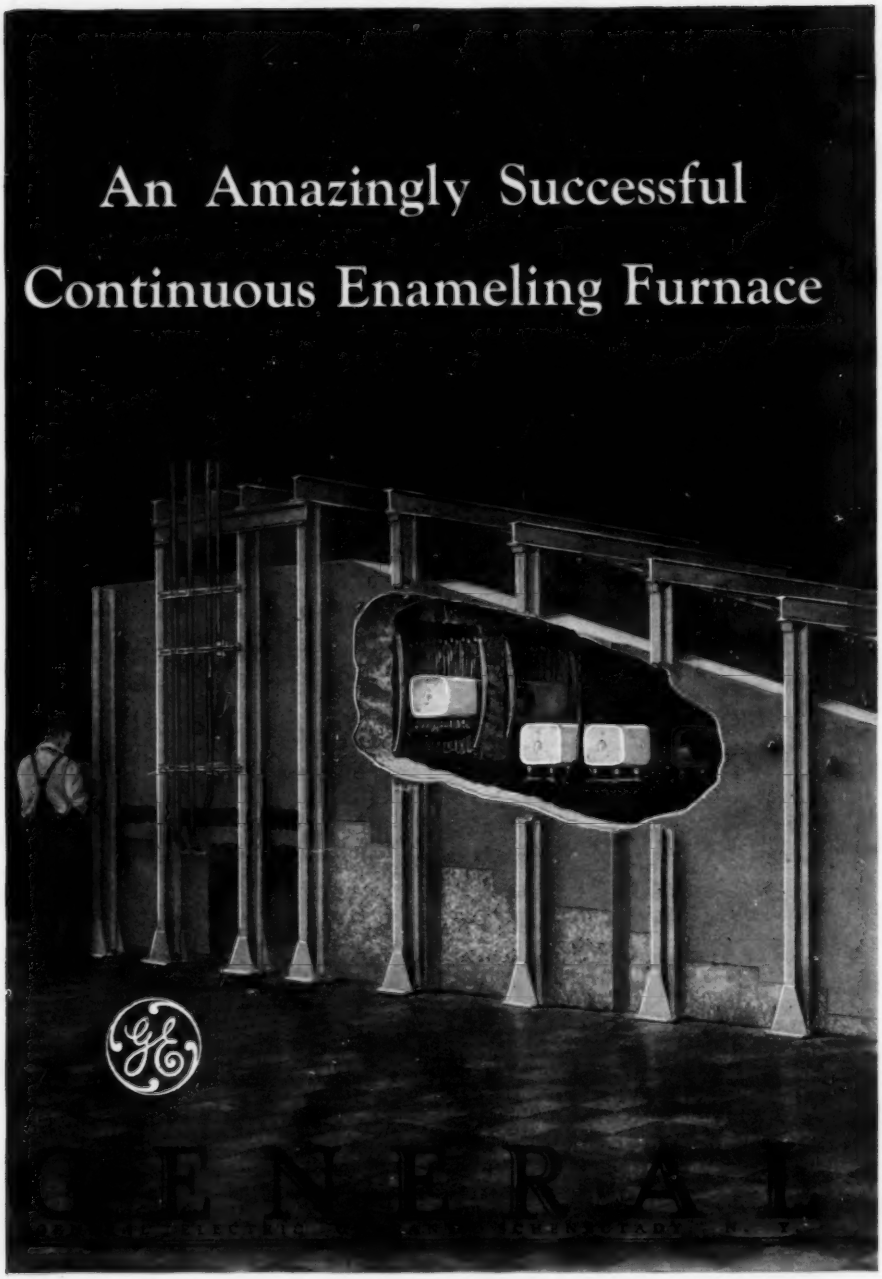

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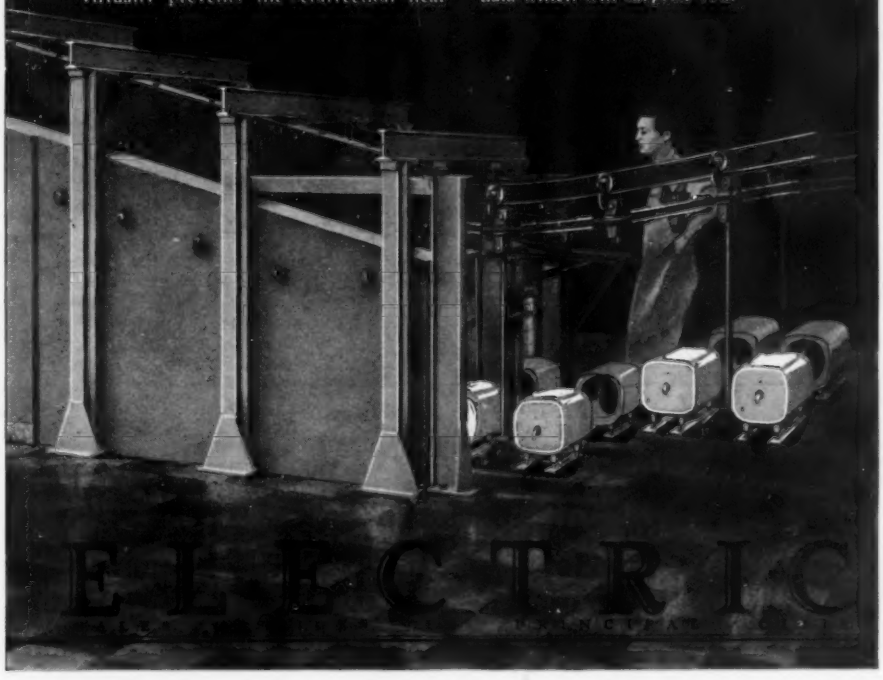

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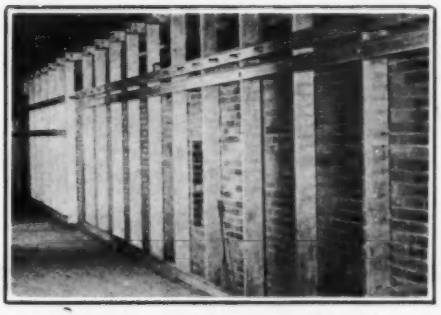

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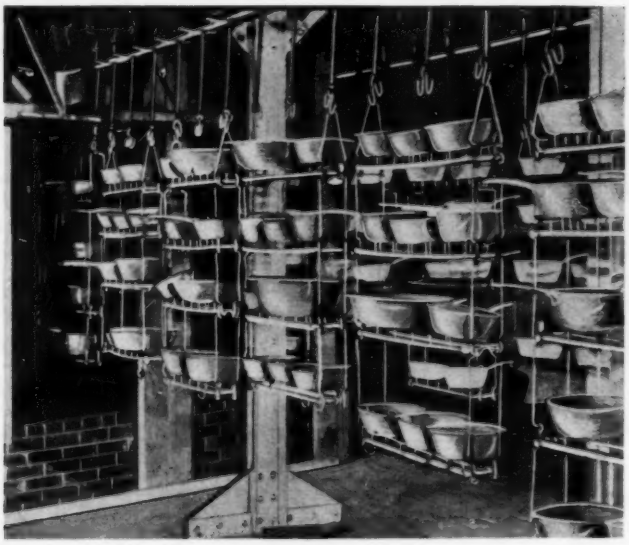

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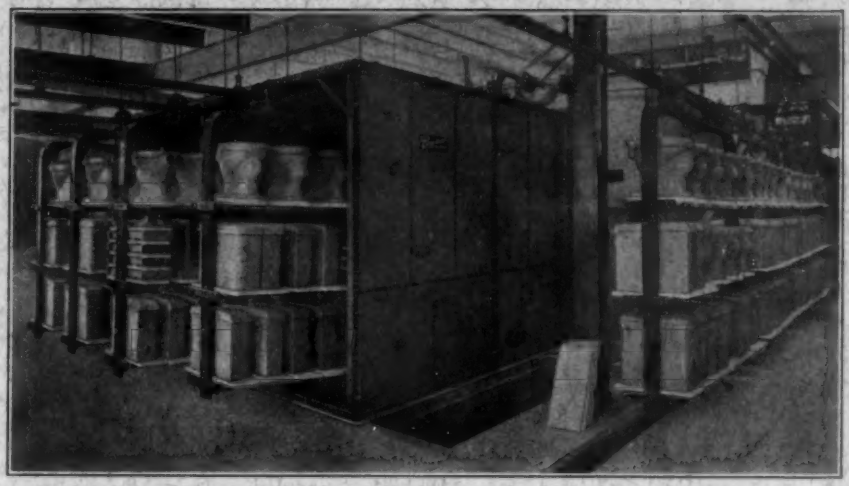

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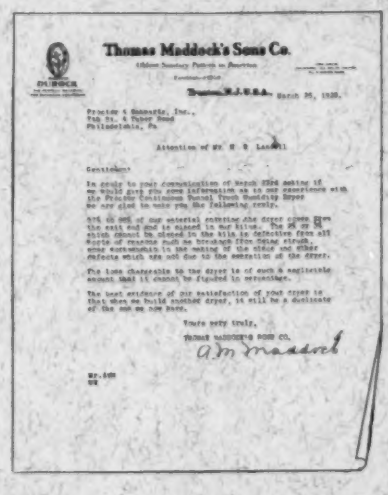

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Editorial and Advertising Offices: 2525 N. High St., Columbus, Ohio.

Executive Office: 2525 N. High St., Columbus, Ohio.

Committee on Publications: F. K. Pench, *Chairman;* A. Silverman, L. Navias, J. Spotts McDowell, A. E. R. Westman, Ross C. Purdy.

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